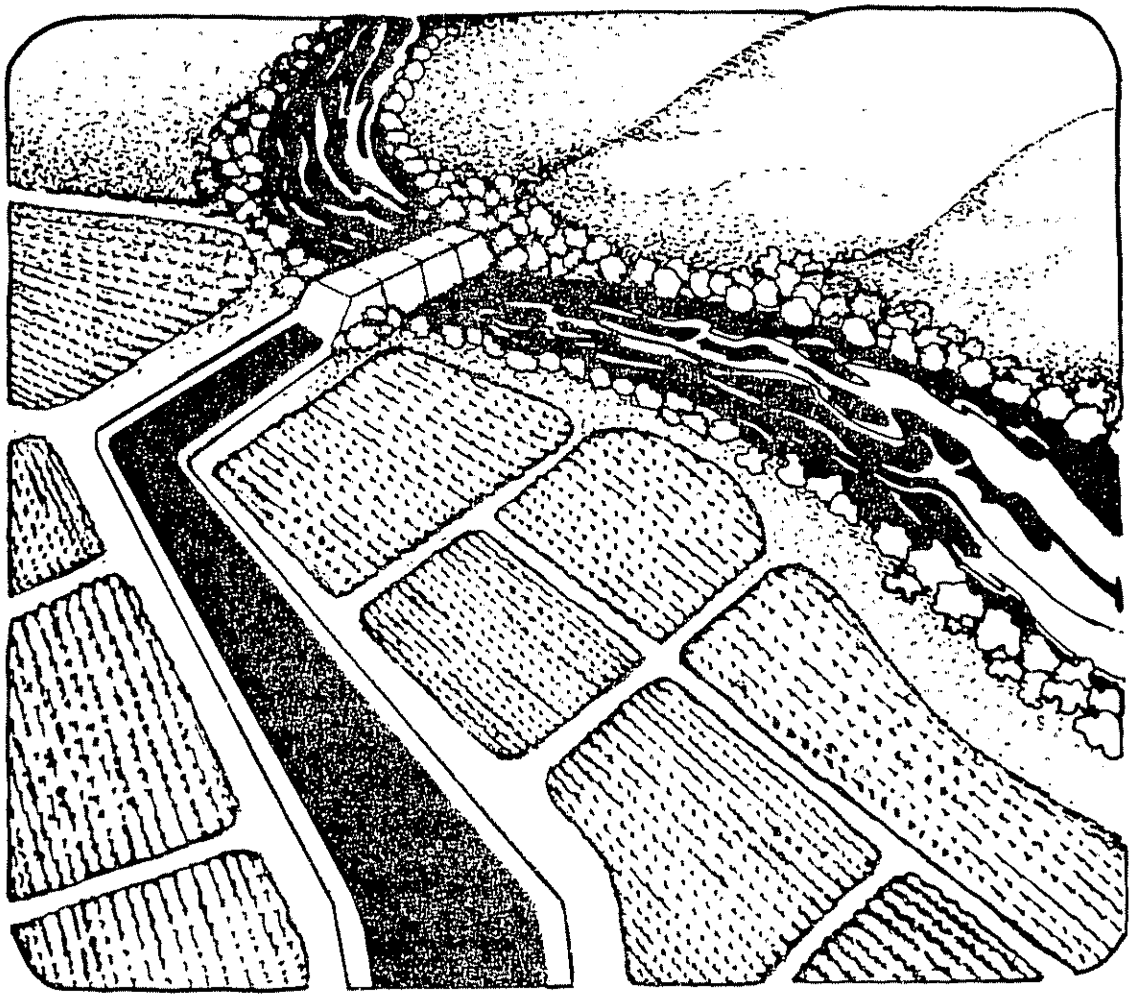
SUPPLEMENT NO. 7

California's Water Resource



Cooperative Extension **University of California**
Division of Agriculture and Natural Resources

LEAFLET 21379

California's Water Resource

California has water problems, largely because most water comes from the north and most demand is in the south, where the supply is limited and competition for water is increasing. But at the same time, California has immense water resources

The state's water comes from two major sources: surface streamflow from rainfall and melting of the mountain snowpack, and groundwater pumped from the state's aquifers. Streamflow and groundwater both originate from moisture in the earth's atmosphere, but in looking at the state's yearly available water resource they may be considered separately

The Problem

At present, most Californians have available all the water they want, for a price—but only by using more of the resource than is being renewed. Groundwater overdraft is evidence of this. The outlook is for even greater demand for water as population continues to grow and possibly for a smaller developed supply because California's share of Colorado River water will shrink

Meanwhile, competition is increasing for the limited supply of developed water. In addition, there is the dilemma of distribution—the north has most of the water but most of the need is in the south

These underlying conditions show up in the form of certain specific problems. For example:

- Groundwater overdraft, most severe in the San Joaquin Valley
- Reduced streamflow in some places (Trinity River, San Joaquin River, Mono Lake)
- Increasing soil and water salinity in the lower San Joaquin Valley
- The fact that present facilities of the State Water Project cannot provide all the 4.2 MAF of water that the state has contracted to deliver in the future

These problems and others must be faced even if the weather remains normal. They could be far worse if there is another drought like the one in 1975-76

And to complicate all this, new water development in California has become much more costly and public decisions on water have become much more complex

Surface water supply

In an ordinary year surface streamflow is the state's largest source of water. The California Hydrologic Balance chart shows that almost all of this runoff comes from precipitation inside California. But more than half of the total never reaches the rivers and streams—it moves into the atmosphere as evaporation and as transpiration from plants in forests, rangelands, and other natural areas.

How much of the total runs off the land and accumulates in the rivers for all other uses, such as drinking water, irrigation, groundwater recharge, and fish? Hydrologists estimate this amount, in an average year, at about 74 million acre-feet (MAF). Two points are important: First, 74 MAF is a great deal of water, as explained in How Much? Second, that figure reflects the *average* yearly precipitation. Most years are not average; in fact, the annual streamflow in California during the past 100 years has ranged from 18 MAF to more than 135. However, average figures are used here to suggest quantities of water and to make comparisons

How Much?

An acre-foot of water is the amount it would take to cover one acre of land one foot deep. That's roughly 326,000 gallons. Most crops are irrigated with two to four acre-feet of water per acre per year. Coincidentally, suburban land covered with houses and landscaping uses about the same amount of water per acre.

How much is 74 *million* acre-feet of water—California's average annual streamflow? That is enough water to fill Shasta Lake, the state's biggest reservoir, more than 16 times. It would water all of the state's irrigated farmland for more than two years.

In addition to the 74 MAF of average streamflow within the state, Southern California imports 4.8 MAF of Colorado River water annually. This amount will decrease by 0.4 MAF in 1985 when the Central Arizona Project begins using Colorado River water

CALIFORNIA HYDROLOGIC BALANCE

(Millions of acre-feet)
(Average year)

Incoming	
Precipitation	193.0
Inflow from Colorado River	4.8
Inflow from Oregon	1.4
Total	199.2

Holdover storage:
Groundwater
Reservoirs and lakes

Outgoing	
Evaporation and plant transpiration	147.1
Outflow:	
To Pacific Ocean	48.8*
To saline sinks	3.9
To Nevada	1.2
Total	201.0†

**Includes 1.4 MAF of reserve supply, developed in some areas but not presently used, and not available to other areas because of a lack of facilities or institutional arrangements*

†This figure is 1.8 MAF larger than the Incoming total. The difference represents California's average annual water deficit, reflected as groundwater overdraft

Where surface water goes

Roughly one-third of the average annual streamflow within California is stored in reservoirs and/or diverted through canals and aqueducts. This is known as the "developed supply." The remaining two-thirds replenishes the groundwater supply and some is lost by evaporation—but most eventually flows to the ocean. Here are details of where surface water goes:

In-state developed supply

Local water projects using local sources	9.4 MAF
Central Valley Project and other federal irrigation projects	9.1 MAF
State Water Project, for San Joaquin Valley and Southern California	2.5 MAF
Other intrastate transfers—examples: Los Angeles (Owens Valley), San Francisco (Hetch Hetchy)	1.1 MAF
Storage for release to augment salinity repulsion in the Delta	1.1 MAF
Total	23.2 MAF

Undeveloped river outflow

To the ocean in North Coast rivers designated as "wild and scenic" (Eel River, Klamath River, and so on)	17.8 MAF
To the ocean in other streams along the coast and through San Francisco Bay—also to inland salt sinks	24.5 MAF
Designated for salinity repulsion in the Delta, then to the ocean	3.6 MAF
To Nevada (Truckee, Carson, Walker rivers)	1.2 MAF
Total	47.1 MAF
Evaporation from lakes and reservoirs	1.2 MAF
To groundwater from river channels	4.6 MAF

Groundwater resource

California's subterranean reservoirs probably contain over 850 MAF of fresh water, but much of this supply is far below the surface and not readily available. (Additional empty storage space in the state's aquifers is estimated at about 160 MAF.) Only about 16.4 MAF of groundwater are pumped out in an average year. Even so, the underground supply provides about 40 percent of the water used by California farms and cities.

Meanwhile, the groundwater supply is recharged from (1) natural percolation (about 5.8 MAF per year), (2) recharge as a result of applied water, mostly irrigation (about 7.4 MAF), (3) planned artificial recharge (about 1.1 MAF), and (4) seepage from conveyance systems (about 0.3 MAF).

But there is a problem: Total average yearly recharge (14.6 MAF) does not equal the amount pumped out (16.4 MAF). Statewide, the average deficit, or groundwater overdraft, is about 1.8 MAF each year. The principal area of overdraft is the San Joaquin Valley, where the yearly shortfall is estimated at 1.2 MAF or more.

Developed water distribution

So far, California's total water supply has been considered—how much enters the system, how much goes out, and to where. Another way to look at California's water resource is to see what happens to *developed* water. The total amount of developed surface and groundwater in California in an average year is about 45 MAF from the following sources:

Water diverted from instate streams	23.2 MAF
Pumped groundwater	16.4 MAF
Water imported from the Colorado River	4.8 MAF
Reclaimed waste water	0.7 MAF

Who uses this supply? About 85 percent of all water applied in the state is used to irrigate farmland; cities and industries use most of the remainder. A small amount of developed water goes to wildlife and recreation uses.

What happens to developed water during and after use? In particular, how much is consumed—that is, disappears from the supply—and how much stays in the system?

Of course, water doesn't really disappear as it moves into another stage of nature's hydrologic cycle. From the viewpoint of California's available supply, however, water is "lost" when it (1) moves into the atmosphere as water vapor, or (2) becomes too salty to use. The latter happens when water flows into the ocean, into inland saline waters such as the Salton Sea, or into other surface or subsurface saline areas.

A large part of California's developed water supply, as well as undeveloped water, actually disappears in these ways. In fact, more than half of all water applied for various uses in the state (25 of 42 MAF) moves into the atmosphere through evaporation and transpiration from plant leaves. This occurs primarily in irrigated agriculture as part of the natural process of crop growth.

Most remaining developed water (about 17 MAF) stays in the system after use, moving either into surface streams or by percolation down to groundwater. It often loses some quality (more dissolved salts or other contaminants) but still is usable. A portion is lost to saline sinks and to the air by evaporation and plant transpiration in non-cropped areas.

Agricultural and urban water use

In an average year, farmers in California apply almost 36 MAF of irrigation water. About 60 percent of this transpires or evaporates to the atmosphere, and about 20 percent percolates down to groundwater. The remainder (over 8 MAF) is surface return flow. This is what happens to it:

Reused on neighboring farms	3.1 MAF
Returned to streams and reused	2.4 MAF
Used for salinity repulsion	0.4 MAF
Lost through additional evaporation and flows to salt water	2.2 MAF

Urban areas in California receive 5.8 MAF in an average year. This is what happens to it:

Treated wastewater (0.9 MAF is reclaimed and is available for reuse; 0.1 MAF evaporates; and 2.4 MAF is discharged, mainly to the ocean)	3.4 MAF
To groundwater through percolation, or to the air through evaporation and transpiration	2.4 MAF

Data Source

Data on water supply and use in this leaflet were provided by the California State Department of Water Resources as of August 1983.

These data represent an update of figures reported in the *California Water Atlas* (published 1978, 1979).

This publication was prepared by Raymond Coppock, Communications Specialist, Cooperative Extension, based on information provided by David C. Davenport, Water Specialist, and Robert M. Hagan, Professor of Water Science, Department of Land, Air, and Water Resources, and Water Specialist, Cooperative Extension, Davis.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jerome B. Siebert, Director of Cooperative Extension, University of California.

5m-4/84-SHG/ALS

PRINTED APRIL 1984

SUPPLEMENT NO. 8

TELEPHONE 619 339 9200

IMPERIAL IRRIGATION DISTRICT

OPERATING HEADQUARTERS • IMPERIAL CALIFORNIA 92251

January 3, 1985

IIDXO

Mr. John A. Replogle
Research Hydraulic Engineer
U. S. Water Conservation Laboratory
4331 East Broadway Road
Phoenix, AZ 85040

Re: Memorandum of Understanding
Cooperative Delivery Response Study

Dear Mr. Replogle:

With reference to your letter of December 11, 1984, in which you offer to provide technical assistance to the District in a joint study of lateral fluctuations and delivery response, we offer this Memorandum of Understanding for your concurrence.

The U. S. Water Conservation Laboratory (US Lab.) will do the following:

1) Provide technical assistance in designing flow-measuring devices.

2) Provide some labor (4 or 5 man crew) to assist in installation of the measuring devices.

3) Assist in the evaluation of potential flow monitoring equipment and work closely with industry in developing improved open channel flow-sensing equipment at a reduced cost.

4) Provide assistance in the development of data collection procedures and the development of computer programs for processing the head measurements.

5) Assist in the collection of the data by providing a person on a part-time-basis from the Agricultural Research Service to periodically visit each monitoring site and collect the stored data.

6) Analyze the collected data and publish the research results in a form acceptable and usable by the Imperial Irrigation District.

7) Share results of evaluation and furnish the District with a brief progress report each June and December.

The District agrees to:

1) Furnish labor and equipment to install and maintain measuring equipment, as time and funds allow, on at least two laterals.

2) Collect measurement data regularly, and furnish all such information to the US Lab. monthly.

3) Cooperate in the analysis of collected data.

Jesse Silva, Chief Civil Engineer, shall be in full responsible charge of the program.

This memorandum shall become effective immediately and shall remain in effect through December 31, 1986, unless terminated by mutual written agreement.

Please sign the duplicate of this letter and return to us promptly.

Sincerely,

Charles L. Shreves

CHARLES L. SHREVES
General Manager

Robert E. Carberry

ROBERT E. CARBERRY
Contracting Officer

U. S. WATER CONSERVATION
LABORATORY
Phoenix, Arizona

SUPPLEMENT NO. 9

No. 5-AG-30-03490

AGREEMENT BETWEEN THE
BUREAU OF RECLAMATION AND THE
IMPERIAL IRRIGATION DISTRICT
TO PROVIDE FOR AN ADVANCE OF FUNDS TO
SUPPLEMENT AVAILABLE APPROPRIATED
FEDERAL FUNDS FOR THE CANAL LINING AND SYSTEM IMPROVEMENT STUDY

1. THIS AGREEMENT, made this 3rd day of June, 1985, pursuant to the Act of Congress approved June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto particularly the Act of September 7, 1966, 80 Stat. 707, all of which acts are commonly known and referred to as Reclamation Law, between the Bureau of Reclamation, represented by the Regional Director, Lower Colorado Region, hereinafter referred to as the "Bureau" and the Imperial Irrigation District represented by the President, Board of Directors, of the Imperial Irrigation District hereinafter referred to as the "District".

WITNESSETH THAT:

Explanatory Recitals

2. WHEREAS, the Bureau as part of the planning effort for improved conservation of Colorado River water is studying opportunities for water conservation in the District with the principal objectives of determining economic feasibility of structural and non-structural conservation measures previously identified in the Water Conservation Opportunities, Imperial Irrigation District Special Study and of developing a water conservation plan to implement economically feasible conservation measures that would make additional water available for use within the District or elsewhere in southern California; and

WHEREAS, the District in a letter to the Regional Director, dated April 10, 1984, indicated an interest in sharing costs of the study with the Bureau; and

WHEREAS, it is the policy of the Bureau to support planning partnerships with local interests aiding in the funding of water resource projects;

NOW THEREFORE, in consideration of the premises and mutual covenants herein contained, it is agreed as follows:

Scope of Work

3. To the extent that funds are advanced by the District as hereinafter provided and that Federal funds are appropriated for this purpose, the Bureau will, with inhouse professional staff or by contract, use said funds to conduct hydrologic, engineering, and environmental analyses required by this investigation as described in the Imperial Irrigation District Plan of Study (POS) dated November 1984. In-kind services provided by the District may be supplied in lieu of funds to be advanced by the District. Continuation of this investigation beyond fiscal year 1985 is contingent upon appropriations by the Congress for this purpose. No liability shall occur to the United States for services or funds provided by the District in excess of available appropriations.

Work Program

4. The parties hereto have agreed to a work program which consists of hydrologic, engineering, and environmental studies sufficient for use in

developing feasibility design and cost estimates for canal lining and automation, regulating reservoirs, a spill interceptor system, and analysis of onfarm and system management programs. The work program is estimated to cost $972,000. The work program to be accomplished shall be commenced and prosecuted with reasonable diligence with an objective of completion on or before September 30, 1987. It is understood that, before or during the progress of the work by the Bureau hereunder, the work program may be reviewed and changes therein may be made when agreed upon in writing by the authorized representatives.

Advance of Funds

5. The District shall advance funds and/or provide in-kind services at such times after January 31, 1985, and in such amounts not exceeding $486,000 in total, as the Bureau may request in order to maintain a work schedule for completion of the project by September 30, 1987. Funds shall be remitted to the Bureau within 30 days of the date of notification. Said funds and services shall be utilized by the Bureau for the work program herein contemplated. Costs of performing the work program will include all expenditures of the District for in-kind services and of the Bureau in connection therewith, involving hydrologic, engineering, and environmental analyses of the District distribution and drainage systems including associated overhead, general expenses, and other services, all as determined by the Bureau.

In-kind Services

6. The parties hereto have agreed that in-kind services supplied by the District will consist of, but not necessarily be limited to, the following:

a. Installing and/or constructing water measuring and recording devices, regular servicing of said devices, and data collecting at specific lateral turnouts, spillways, or other locations to be mutually identified during the execution of the work program.

b. Rating existing water control structures along the East Highline Canal to develop water level versus flow relationships. Specific structures will also be identified during execution of the work program.

c. Assembling and/or tabulating engineering and District operational data consisting of physical specifications for existing distribution and drainage system features, canal and lateral flow records, turnout delivery records, etc.

d. Analyzing potential operation and maintenance cost savings resulting from construction of various proposed water conservation features.

e. In-kind services provided by the District for this study will be limited to work items identified in the POS unless additional work is mutually agreed to by the authorized representatives of the District and the Bureau.

f. The reasonable value of in-kind services provided by the District or the District's designee shall be credited toward the payment of the District. Credit toward payment shall be limited to the District's usual and customary cost accounting and billing procedures associated with supplying such services. In the event of disagreement regarding the reasonable value of the in-kind services, the determination of the Regional Director, Boulder City, Nevada, following negotiations between authorized representatives, shall be conclusive upon the parties: Provided, however, That such determination shall not be predicated upon arbitrary, capricious, or unreasonable opinions or determinations.

Unused Funds

7. In the event that any funds advanced to the Bureau are not required to complete the work program, such excess funds, shall be returned by the Bureau to the District; Provided, however, That in the event the authorized representatives agree on additional work of the character contemplated by this Agreement, such excess funds may be readvanced to the Bureau or retained by the Bureau with the approval of the District.

Shortage of Funds

8. If said work program results in fund expenditures greater than said \$972,000 the Bureau and District will each be responsible for 50 percent of any additional funding required to complete said program, contingent upon the availability of appropriations for this purpose.

Accounting of Funds

9. Separate accounts shall be maintained by the Bureau for all work items financed with funds received from the District. Likewise, the District shall maintain books, records, documents and other evidence in such detail as will properly reflect all costs incurred under the terms of this Agreement. These

accounts and records shall be available for inspection, audit, or reproduction by the District or Bureau representatives upon written request. The District shall on a quarterly basis submit to the Bureau an accounting record of cash advanced and in-kind services furnished as provided herein above showing specific types of services furnished and associated cash values.

Authorized Representatives

10. The General Manager, Imperial Irrigation District, and the Regional Director, Lower Colorado Region, shall be the authorized representatives of the District and Bureau, respectively.

Availability of information to Bureau

11. All District maintained information and data required by the Bureau for performance of the work program and/or information and data developed by the District or the District's designee as in-kind services shall be provided to the authorized representative of the Bureau.

Availability of Information to District

12. All information and data obtained or developed by the Bureau in connection with performance of the work program (exclusive of intra-Governmental communications) shall be available upon request to the authorized representative of the District.

Termination

13. This agreement shall terminate upon written notification that:

(a) The work contemplated by this Agreement has been completed, or

(b) The amount of Nine Hundred Seventy Two Thousand Dollars ($972,000) has been expended as contemplated herein, subject to Article 8 above, or

(c) Upon written notification by either party with 90 days notice; Provided, however, That in the event the agreement is terminated by either party before the work has been completed, any unused portion of the funds advanced by the District shall be returned to the District by the Bureau. A concluding report summarizing work program accomplishments at time of termination will be prepared by the Bureau.

Officials not to Benefit

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit arising from it. However, this clause does not apply to this agreement to the extent that this agreement is made with a corporation for the corporation's general benefit.

Disclaimer

15. This Agreement and acceptance of said funds does not obligate the Bureau to the construction of any conservation features studied during the course of the investigation.

IN WITNESS WHEREOF, the parties have caused this agreement to be duly executed the day and year first here in above-written.

BUREAU OF RECLAMATION

JUN 3 1985

Date

by

Regional Director
Lower Colorado Region
Bureau of Reclamation

IMPERIAL IRRIGATION DISTRICT

MAY 14 1985

Date

by W. R. Condit

President, Board of Directors
Imperial Irrigation District

SUPPLEMENT NO. 10

State of California
Edmund G. Brown Jr., Governor
Resources Agency
Department of Water Resources

Advisory Panel on Agricultural Water Conservation

(May 1979)

* * *

Report of Findings

Co-Sponsors

Senate Committee on Agriculture and Water Resources

Assembly Committee on Water, Parks, and Wildlife

California Water Commission

California Energy Commission

Department of Food and Agriculture

State Water Resources Control Board

University of California

Copies of this bulletin are available without charge from:

State of California
DEPARTMENT OF WATER RESOURCES
P. O. Box 388
Sacramento, California 95802

May 18, 1979

Mr. Ronald B. Robie, Director
Department of Water Resources
P. O. Box 388
Sacramento, CA 95802

Dear Mr. Robie:

As Chairman of the Advisory Panel on Agricultural Water Conservation, which convened at Asilomar, California, on May 12 through 18, 1979, I am pleased to report to you the Panel's conclusions regarding the feasibility of water conservation in the State's principal agricultural sectors. The Panel you assembled represents an unprecedented event in the history of the State, with ten eminent conservation experts having the opportunity to apply their knowledge and experience to California's water shortage problems.

The attached report includes the Panel's specific findings and detailed comments. In summary, the Panel concludes that a substantial potential exists for conserving water in California's irrigated agricultural sectors. The magnitude of potential savings varies from area to area, but statewide implementation of water conservation measures will reduce water shortages that have been forecast for the near future, without curtailing agricultural production or economic activity.

As you know, irrigation practices in California have already reached a high level of proficiency. Yet, further improvements aimed at reducing the amount of water used consumptively, or lost through inefficiency in the agricultural sectors, can and should be sought, considering the finite character of the State's natural resources.

Substantial amounts of brackish drainage water--currently unused--could bolster irrigation supplies if the use of salt-tolerant plants intensifies. Further, to encourage farmers to implement changes in their irrigation and cropping patterns, government should offer appropriate economic and financial incentives.

We think it is important that the State of California improve its quantitative data base on the use of irrigation water, as well as on the available ground water resources. The State should also develop a mechanism for ground water management to protect that resource and integrate its use with that of surface water.

Implementation of all these recommendations can be initiated without delay, and they will result in water conservation. However, for these measures to be fully effective, a number of changes also must be made to the State's institutions related to water resources. These include considerations of the gradual adoption of replacement cost pricing for surface and ground water, the transferability of water rights, and the establishment of an overall ground water regulatory authority.

Finally, a number of research needs were identified by the Panel with regard to water conservation, irrigation techniques and the use of salt water. Recommendations are included in the report for priority research programs.

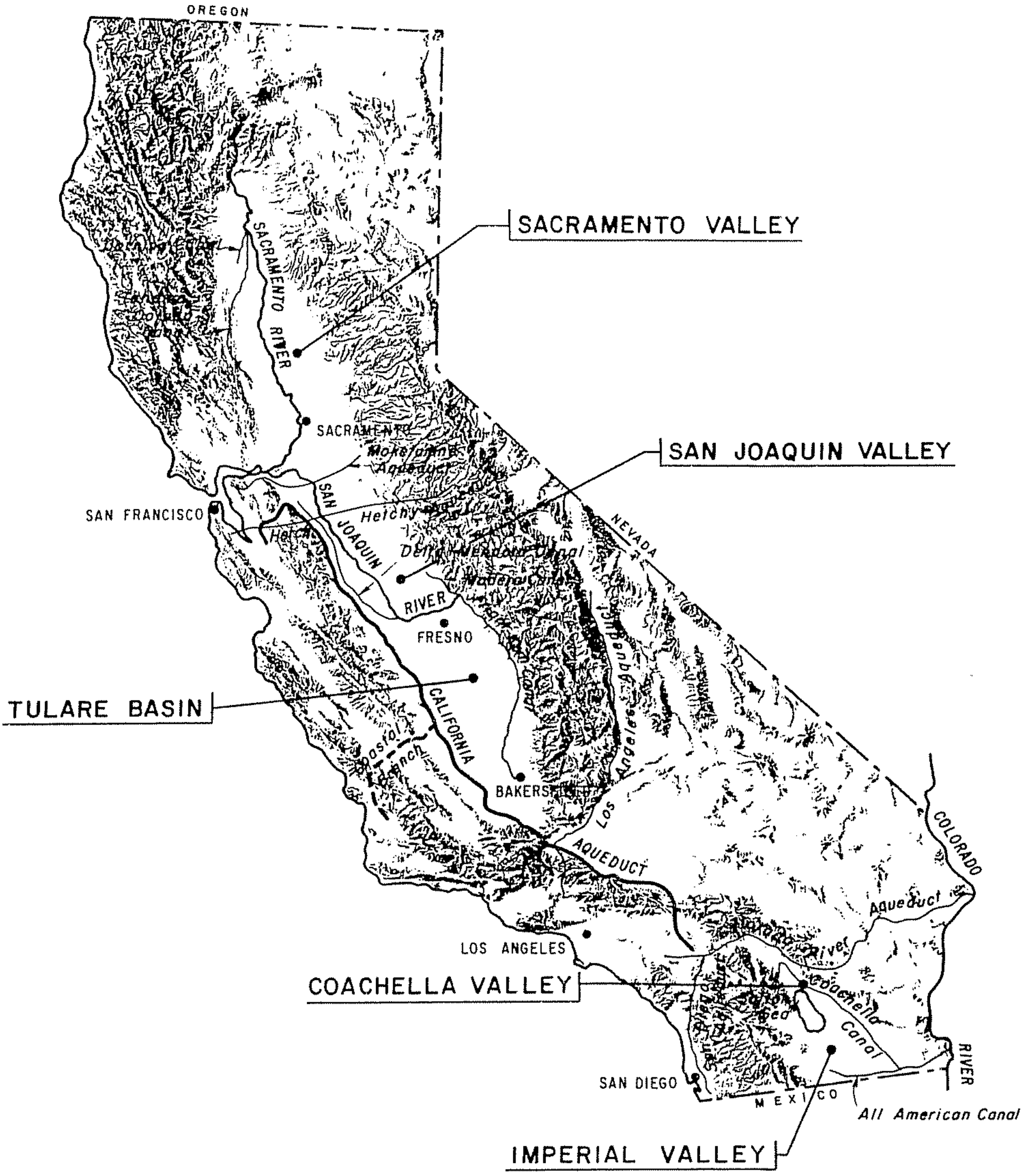
On behalf of the Panel, I wish to express our appreciation for being given this opportunity to suggest a program for conservation of agricultural water in California.

Very Truly yours,

Marcel Bitoun

Marcel Bitoun, Chairman
Advisory Panel

Figure I. STUDY AREAS AND MAIN AQUEDUCTS



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CHAPTER 1. INTRODUCTION AND SUMMARY

This report summarizes the findings of an Advisory Panel on Agricultural Water Conservation assembled in Asilomar, California, from May 12 through May 18, 1979. The Panel's objective was to formulate recommendations to the State of California regarding the feasibility of Water conservation in the State's principal agricultural sectors.

The Panel included the following water resources experts:

Mr. Marcel Bitoun, Chairman of the Panel: Vice President, Harza Engineering Company, Chicago, Illinois

Mr. Larry R. Swarner, Vice Chairman of the Panel: Chief, Land Resources Management Branch, Bureau of Reclamation, Denver, Colorado

Dr. Robert D. Burman: Professor, University of Wyoming, Laramie, Wyoming

Mr. Leonard J. Erie: Irrigation Engineer, U.S. Department of Agriculture, Fort Collins, Colorado

Dr. Del D. Fangmeier: Professor, University of Arizona, Tucson, Arizona

Dr. Dale F. Heermann: Agricultural Engineer, U.S. Department of Agriculture, Fort Collins, Colorado

Dr. Daniel Hillel: Professor, University of Massachusetts, Amherst, Massachusetts

Dr. Richard B. Norgaard: Economist, Ford Foundation, Rio de Janiero, Brazil

Dr. Robert T. Ramage: Professor, University of Arizona/U.S. Department of Agriculture, Tucson, Arizona

Dr. Jan van Schilfgaarde: Director, Salinity Laboratory, U.S. Department of Agriculture, Riverside, California

Besides the Panel's technical deliberations, two days of hearings were held, during which 27 individuals presented their views on agricultural water conservation to the Panel, on behalf of Federal and State government agencies, public and private non-government organizations, and the University of California. The names of these individuals, and the organizations thev represent, appear in the appendix to this report. Formal presentations made by these individuals were included in the Panel's record.

Terms of Reference

As part of its terms of reference, the Panel was given five questions to consider:

--What is the potential for agricultural water conservation in California's three great valleys: Sacramento, San Joaquin, and Imperial?

--What changes in irrigation practices could be undertaken to realize this potential, taking into account current agricultural methods, economics, and farmers' willingness to modify their customary routines?

--How can State government promote changes in irrigation practice that would save water and still maintain or improve economic return and crop yield?

--How can farmers increase the use of reclaimed waste water and brackish water for irrigation?

--What areas of research should water experts emphasize to implement irrigation water savings?

After addressing these questions in its deliberations, the Panel developed this report.

Summary

The Panel concludes a potential exists for conserving water in California's irrigated agricultural sectors. The potential varies from area to area, but statewide implementation of water conservation measures will help reduce the water shortages forecast for the near future, without curtailing the present level of agricultural production or economic activity.

Irrigation practices in California have already reached a high level of proficiency. However, further improvements aimed at reducing the amount of water used consumptively, or lost through inefficiency in agricultural sectors, can and should be sought, in view of the finite character of the State's natural resources.

Substantial amounts of brackish drainage water--currently unused--could bolster irrigation supplies if research in such areas as the breeding of salt-tolerant plants intensifies. A broad program of education regarding irrigation water conservation should be implemented. Designers, operating personnel, and farmers need an expanded level of technical assistance to aid in water conservation. This assistance should include irrigation scheduling information for all water users. Further, to encourage farmers to implement changes in their irrigation and cropping practices, government should offer appropriate economic and financial incentives.

The State of California should improve its quantitative data base on the use of irrigation water, as well as on available ground water resources. The State should also develop a mechanism for the management of ground water to protect that resource and integrate its use with that of surface water. At the public hearings, the Panel observed that the large number of entitites that share responsibilities for California's water management make statewide coordination very difficult. For this reason, the Panel recommends closer coordination and cooperation among the many water agencies.

A number of institutional measures are also recommended. They include consideration of the gradual adoption of replacement cost pricing for surface and ground water, and the establishment of an overall ground water regulatory authority.

Finally, the Panel identified a number of research needs with regard to water conservation potentials in agriculture, and formulated recommendations for priority research programs.

Specific findings and detailed comments are contained in the remainder of the report.

The purpose of irrigation is to supply the water needed (over and above natural rainfall) for crop growth (biomass production), for evapotranspiration as required by the climatic environment, and prevention of salt accumulation in the root zone. Together, these three functions determine the minimum amount of water required to grow a crop.

The ultimate aim of good irrigation practice is to apply only amounts of water that will meet crop requirements. Inefficiency occurs when greater amounts are applied and lost through percolation, evaporation, runoff, etc. Some losses are inevitable because of less-than-ideal field conditions.

Irrigation efficiency, as used by the Department of Water Resources, is defined as follows: On-farm irrigation efficiency is the ratio of evapotranspiration of applied water (ETAW) to the applied water (AW). ETAW is the sum of the products of unit ETAW in feet and acreage of each crop within the study area. Unit ETAW values are an index of potential biomass production and are usually taken from authoritative sources such as Bulletin 113-3 of the California Department of Water Resources. It should be noted that according to the Department's definition, the attainable efficiency will be less than 100 percent where precipitation is insufficient to meet minimum leaching requirements, and irrigation water must be supplied for this purpose.

Basin efficiency is defined as the ratio of evaporatranspiration of applied water ETAW to basin water demand. The Department uses the concept of basin efficiency to relate ETAW to the demand on principal water supplies, i.e., releases from reservoirs, pumping from wells, etc. This "basin demand" is the quantity of water needed to meet ETAW, plus all other irrecoverable losses incidental to irrigation, plus return flows leaving the basin.

Reducing Transpiration

Transpiration by crops is an inevitable consequence of growth. Theoretically the amount of transpiration has an upper limit, called "potential evapotranspiration", which is an agroclimatic parameter. The actual rate of transpiration in the field may fall below the potential rate per unit area if the crop is sparse or the soil moisture scarce.

As a rule, total growth (dry-matter production) increases linearly with transpiration. With many crops, the economic yield is roughly proportional to total growth; hence transpiration cannot be reduced without curtailing yield. On the other hand, the economic yields of some crops are disproportional to their total growth, so the possibility of reducing these crops' transpiration by such measures as short-season or cool-season varieties, or by various cultural practices, warrants further investigation. Still, even though a water conservation strategy may aim at maximizing the marketable crop yield per unit of water consumed, planners must remember that reductions in transpiration will usually reduce crop yields.

Reducing Direct Evaporation

Direct evaporation of water from the soil surface can be reduced in many cases. However, the energy balance of the field is such that direct soil moisture evaporation and plant transpiration (generally lumped together under the term "evapotranspiration") are closely-coupled processes: a reduction of one tends to increase the other.

In the case of close-growing crops, the net savings of water from evaporation reduction is negligible. The situation is different in the case of "open" crop stands, such as young orchards, where the soil surface remains largely bare for prolonged periods of time. Here, a water savings of perhaps 20 percent can result from the suppression of evaporation by mulching, or the adoption of specialized irrigation methods that wet only a small fraction of the land.

Irrigation Systems

The improvement of physical systems for on-farm irrigation is often considered to offer the best potential for achieving water conservation. However, the management of these systems is an equally important factor that must also be stressed. Well-managed irrigation systems can have equally high efficiencies whether they are gravity, sprinkler, or drip design. Conversely, poorly designed or ill-managed systems will result in low efficiencies. The numbers often quoted for the efficiencies of various types of irrigation systems are not based on field measurements, but on consensus estimates subject to large errors. For example with drip systems, experience indicates efficiences far lower than the 90 percent often expected.

Avoiding Runoff and Excessive Percolation

Avoiding runoff is an important aspect of water conservation. Runoff is a common occurrence with surface irrigation systems, although it is practically eliminated in "basin" irrigation systems. Surface water excess and runoff not only cause water loss to the irrigated field, but also entail the risk of erosion, sedimentation, contamination, and mosquito infestation. Properly tailoring the irrigation method to the soil's infiltration capacity can minimize or even prevent runoff. And where runoff cannot be avoided, "tail water" can often be pumped back onto the same field, directed to some field at a lower elevation, or channeled to some other downstream user. Thus, surface runoff does not necessarily reflect a low basin irrigation efficiency.

Besides runoff, application of water in excess of irrigation requirements may result in deep percolation losses from the field. Since California's irrigation efficiencies--expressed in terms of water retained in the plant root zone, relative to the amount of water delivered to the field--are generally about 60 percent (and often lower), and since efficiencies of 80 to 85 percent are indeed attainable, it appears that in many cases seasonal water application can be reduced by 20 percent.

True, water lost from one field may be reused on another, either by pumping it from ground water or by allowing it to discharge into a stream. But nevertheless, excessive percolation should be avoided insofar as practicable, since it can waterlog the soil, leach nutrients, raise the water table unduly, and cause inadvertent irrigation. It also causes higher production costs. Even where the drained water is reused, as it generally should be (unless excessively saline), its quality tends to be degraded when it percolates through the soil.

Irrigation Management

To increase irrigation efficiency, farmers should have exact and current knowledge of evapotranspiration, and of the current status of soil moisture and salinity in their fields. Moreover, they should be able to obtain water on demand (rather than on a fixed, arbitrary schedule), so as to deliver it in measured quantities to specific fields, and to distribute it uniformly.

Proper scheduling of irrigation applications is also important. Current estimates of irrigation requirements, based on local agroclimatic measurements, as well as knowledge of crop specificity, should be made available to farmers by State or Federal agencies, or by commercial enterprises. At present, such irrigation management services are not universally available throughout the State, though an excellent beginning has been made. For information on proper irrigation scheduling (optimal timing and amount of irrigation) to be effective, it must be coupled with an intensive educational campaign to make potential irrigators aware of the facts so they can use them to their best advantage. The technicians charged with disseminating this information, and demonstrating its use to improve irrigation techniques, must be trained to a high degree of competence.

Efficient irrigation requires planning and skill. And since there appears to be a shortage of qualified irrigation specialists in California, the Panel suggests that irrigation be recognized as a specialty requiring knowledge and skills. It also suggests that the State adopt a set of standards (training, certification, compensation, etc.) by which candidates for the practice of irrigation can be measured.

To ensure proper control over the delivery and on-farm application of irrigation water, farmers should be encouraged to install metering and control devices such as flow meters, pressure regulators, metering valves designed to deliver preset volumes of water, soil moisture and meteorological monitoring instruments, and automatic regulations systems. To provide incentive for the installation of such devices, favorable-term loans or cost-sharing arrangements should be offered. Further, the State's electronic and computer industry should be invited and encouraged to develop systems for the automatic and optimal control of irrigation timing and quantity.

Ground Water

A sound water conservation program requires planned conjunctive use of ground water and surface water--a practice that leads to efficient use of available resources. At present, no such integration exists at the State level, so better information should be obtained on the characteristics of ground water aquifers, and a mechanism for their conjunctive management with surface water sources should be developed.

Plant Breeding For More Effective Use of Water

Using established techniques, plant scientists can produce new cultivars that make more efficient use of available water, even if the quality of that water is poor. Although there is no prior assurance of success, the probability of developing new economic varieties is high.

The development of cultivars that can be nourished with poor quality irrigation water offers California the greatest opportunity for water savings that can result from plant breeding. Large amounts of available saline and reclaimed water may be usable for irrigation with present crops, and the selection of more salt-tolerant species--and cultivars within species--will make it possible to use even more of this poor-quality water. The Panel notes, however, that plant-breeding programs are time-consuming, and that years will elapse before new, more tolerant cultivars can be expected.

Crop yields, although commonly expressed in terms of production per unit of land area, should also be considered in terms of production per unit of water used. The decrease in yield resulting from a reduction in water used varies from species to species, and for cultivars within species. Yield reduction generally is proportional to water savings for forage crops like alfalfa, but it can be relatively smaller for grain crops like wheat. Early-maturing varieties have the potential to produce a higher yield per unit of water applied. Thus, water savings may also be achieved, through breeding, by shortening the growth season or shifting the growing season to a cooler part of the year.

Plant breeding to modify plant structure may also change water-use patterns. A structure may be selected that maintains yield of the desired plant part but reduces total dry matter production concurrently with a reduction in water use. Also, selection for early, rapid ground cover may reduce the evaporation portion of evapotranspiration.

Cropping Patterns and Cultural Practices

A considerable potential exists for water conservation through adjustment or modification of cropping patterns to favor crops that consume less water. Crops can be grown during that part of the year when evapotranspiration is lowest. Growing winter or short-season crops should reduce water use appreciably by curbing evapotranspiration losses. Changing agronomic practices to obtain a ground cover more rapidly should also reduce evaporation. For example, by increasing plant density in, say, cotton to effect an earlier maturity, or by replacing alfalfa with two grain crops grown in sequence, much irrigation water could indeed be saved. Clearly, there is a need for dissemination of existing knowledge and development of new information to provide farmers with a wide range of farming options.

Planned Water Stress (Deficit Irrigation)

Reducing the length and number of on-farm irrigations may result in significant changes in growth habits and total dry-matter production. Timely reductions in water applications may reduce the yield of marketable produce somewhat, while reducing water use appreciably; or they may not affect yield at all. Conversely, the potential for increasing marketable yield without increasing water use needs to be explored further. Different species and sub-species exhibit varying responses to water stress at given stages of plant growth. However it must be emphasized that planned water stress requires a high level of irrigation scheduling.

Use of Secondary Effluent

Each year, California produces well over 2500 million cubic meters (2 million acre-feet) of treated sewage water that could be used for irrigation. It has been demonstrated time and again that such waters can be used effectively for agricultural crops with careful management; but unfortunately, much of this water is produced far from major agricultural areas, and so far its use has been restricted to parks and golf courses. Just the same, expanded use of treated sewage water for irrigation is an important option that must be explored further.

Whether the cost of transport and separate distribution systems makes extensive use of treated sewage water viable depends on the marginal cost of developing alternate sources of supply. Testimony presented to the Panel indicates that, by preliminary estimate, the cost of Bay Area waste water conveyed to the Central Valley should be competitive with the development of new water sources. Regulatory constraints, more than technological barriers, will limit the use of this water.

Whereas a substantial body of information is available on treated sewage water, some questions remain concerning accumulation of toxic elements and the transmission of disease vectors into soils and plants. Consequently, where such treated sewage is used to irrigate field crops, frequent monitoring is desirable to anticipate and avoid adverse effects. It may also be necessary to protect "good faith" sewage-water users against unanticipated future changes in regulations.

Large quantities of effluent are produced in the Central and Southern Coastal Basins. However, if growers found it economical to use this effluent, it would benefit areas served in part with State Project water. Therefore, any "savings" accrued would result in more water for other users in the San Joaquin, Tulare, and Sacramento Basins.

CHAPTER III. THE IMPERIAL BASIN
(Coachella and Imperial Valleys)

The Imperial Basin occupies the extreme southeastern portion of California, encompassing the Coachella and Imperial Valleys. The quality of ground water in the Coachella Valley is good; but the Imperial Valley ground water is generally unsuitable for domestic and irrigation purposes, and most crops are supplied with imported surface water.

Water Delivery and Application

This area (largely served by the Imperial Irrigation District and the Coachella Valley County Water District) is defined as the area tributary to the Salton Sea. Irrigation water is provided to approximately 235,000 hectares (580,000 acres). The water supply for the area is largely from the Colorado River through systems installed many years ago. Water supply for the area is approximately 4200 million cubic meters (3.4 million acre-feet). The amount of water now flowing into the Salton Sea from the Imperial and Coachella Valleys is approximately 1200 million cubic meters (1 million acre-feet) annually. On-farm irrigation efficiencies approximate 66 percent, whereas the basin efficiency is 50 percent. The low basin-efficiency reflects excessively large losses in the conveyance system and little reuse of water.

It appears there is an opportunity to reduce diversions to the Imperial Basin and to make some of the water currently flowing to the Salton Sea available for beneficial uses. This opportunity would in no way affect California's allocation of Colorado River water, and a reduction in the present non-beneficial uses would relieve the problem of rising water elevation in the Salton Sea. The desired elevation of the Salton Sea is a factor that must be recognized.

According to Department of Water Resources' figures, annual conveyance and distribution losses amount to 253 million cubic meters (205,000 acre-feet) in the Coachella Valley and 787 million cubic meters (638,000 acre-feet) in the Imperial Valley. These losses could be reduced substantially by lining canals and ditches, and through other structural improvements. Improved conveyance systems would encourage more efficient irrigation district management. Delivery methods should also be improved or modified as much as possible to increase efficient use of water on the farm. Accurate water measurements should be made, and records kept both at water district offices and on the farms. Measuring devices should be installed where they are not now used.

Concrete-lined ditches and water control and regulation devices can improve on-farm irrigation efficiencies, and the introduction of laser-controlled leveling (a land-leveling process that uses a laser beam sensor to regulate the slope of a field) offers an accurate means to prepare land for efficient irrigation. (Level basin irrigation has improved irrigation efficiencies in comparable areas of other states). Irrigation scheduling programs that coordinate district operations with the farmers' needs will provide the coordination needed to improve the districts' overall management efficiencies.

Incentives other than presently escalating water prices appear to be needed to conserve additional water within the valleys. The State should investigate the setting up of low-interest agricultural loans to improve both on-farm and off-farm conveyance and distribution systems. It is estimated that as much as 500 to 600 million cubic meters (400,000 to 500,000 acre-feet) of water in the Coachella and Imperial Valleys could annually be made available for other beneficial uses. To better define what savings can be accomplished, a site-specific study should be made in each of these valleys, and the most cost-effective measures should be identified before actual physical improvements are initiated.

Drainage Water Reuse in the Coachella and Imperial Valleys

Drainage water in the Imperial and Coachella Valleys consists of both surface and subsurface return flows from irrigated fields. Additionally, the drainage system also collects drainage water from Mexico. This water flows into the Salton Sea, where it ultimately evaporates. Each year, 1600 million cubic meters of water (1.3 million acre-feet), with an average salt content of 3000 milligrams per litre (3,000 parts per million), flow to the Salton Sea. A potential exists for reuse of some of this drainage water for irrigation of selected crop species that can produce good yields with saline waters. Increased irrigation efficiencies would reduce the water available for reuse. Some flow of drainage water to the Sea would still occur, although at a higher salt concentration.

From a technological point of view, reuse of drainage water can probably be implemented faster than irrigation efficiencies can be improved. Application for drainage water to land already under irrigation can directly reduce the diversions by the districts from the Colorado River. The net effects of this practice would be a lower quantity flow of saltier water to the Salton Sea and reduced diversions of higher quality water. The Metropolitan Water District could provide a reuse incentive by purchasing part of the Coachella and Imperial Valleys' water rights. Yet some caution is warranted, since the drainage water from Mexico may contain untreated sewage.

CHAPTER IV. THE SACRAMENTO BASIN

The Sacramento Basin generally includes the northern third of the Great Central Valley and the upper Sacramento River drainage area. It is a basin of abundant and inexpensive surface water supplies, and this is the main reason why its ground water levels, for the most part, are at or near their historical highs.

Water Delivery and Application

The Sacramento Basin contains approximately 600,000 irrigated hectares (1.5 million irrigated acres). Applied water to this area approximates 7200 million cubic meters (5.8 million acre-feet) annually. The on-farm efficiency is 58 percent, and the basin efficiency is 72 percent, as defined by the Department of Water Resources.

Water conservation can be realized in the Sacramento Basin by: increasing farm and basin efficiencies, reducing phreatophytes, curtailing evaporation, and possibly reducing transpiration. However, some water being used at present above the conjunctive-use requirements serves to supply the irrigation requirements at the Delta and prevent the intrusion of salt water. Thus, the potential for water savings is limited.

Irrigation efficiencies could be increased in the basin through improvements in conveyance and distribution systems, modernization of on-farm irrigation facilities, improved land shaping, and better irrigation scheduling. Irrigation scheduling should be coordinated with water management throughout the distribution system. Although the improvement of irrigation efficiencies may not result in additional water, the advantages of keeping the water within the stream, reducing the leaching of fertilizers, minimizing the amount of sediments returning to the stream, and possibly saving energy make conservation worthwhile. As elsewhere, there is also in this basin a need for better water measurements, and records, both on diversions and water use.

CHAPTER V. THE SAN JOAQUIN AND TULARE HYDROLOGIC BASINS

The San Joaquin Basin consists of the entire drainage area of the San Joaquin River and its tributaries upstream from the Vernalis gage. The Tulare Basin comprises the entire drainage area of the San Joaquin Valley south of the San Joaquin River. Although grossly deficient in natural water resources, and subject to a severe ground water overdraft, it is the State's largest and most productive agricultural basin.

Water Delivery and Application

These combined areas contain approximately 2.1 million irrigated hectares (5.3 million irrigated acres), with 27 000 hectares (91,000 acres) of double-cropped land. In 1972, growers applied approximately 23 200 million cubic meters (18.8 million acre-feet) of water to this area. The Department of Water Resources estimates that on-farm losses amount to approximately 8800 million cubic meters (7.1 million acre-feet), of which only 2600 million cubic meters (2.1 million acre-feet) are lost from the system. The remaining 6200 million cubic meters (5 million acre-feet) are reused within the basin. This reuse results in an average farm efficiency of 62 percent, and a basin efficiency of 85 percent.

Because of the continuing ground water overdraft in various parts of the basin, there is a need for water conservation. A potential for water savings exists within the basin through the increase of irrigation efficiencies--an action that would also reduce accretion to the perched water table. Additionally, there is a potential for reusing a considerable amount of drainage water by pumping from shallow wells in the perched water table.

Farm irrigation efficiencies can be increased through further improvements in land shaping for irrigation, improved on-farm distribution-system and water management, and development and use of better automatic control devices. More efficient application of surface and ground water will reduce the ground water overdraft. But to the extent possible, water agencies should store spring and winter flood flows from the Sierra in underground basins within reasonable environmental restraints. Those areas served by the Stanislaus, Tuolumne, and Merced rivers have high water tables and drainage problems that could be lessened by good water conservation practices. Reducing diversions through good conservation practices would leave more water in the rivers.

Although a potential for water savings exists, that potential is not likely to be achieved unless farmers receive some economic incentives. Water should be measured and accurate records maintained. Even with these measures, the projected deficit will probably not be eliminated without a reduction in total irrigated acreage, or an increase in water supplies

Drainage Water Reuse

In various parts of the San Joaquin Basin, and especially in the Tulare Basin, the need for drainage is increasing. Inadequate drainage leads to saturated soils and salination. Adequate drainage requires collector systems and disposal facilities. Even as on-farm irrigation efficiency is maximized, and distribution losses are minimized, there will remain a need for drainage.

Encouragingly, much of the drainage water may be a resource instead of a waste product. To the extent it can be collected and properly distributed, either as is or diluted with fresh water, and to the extent its salinity is not excessive (a practical limit may be 6 000 milligrams per litre TDS ((6,000 parts per million TDS)), such water can be used to irrigate and produce salt tolerant crops such as cotton. Such use would:

--Reduce the volume of drainage water needing disposal

--Result in an economic product

--Extend the available water supply for a fixed area irrigated.

The use described could be implemented concurrently with the development of the drainage system.

A second, more tentative opportunity exists for reducing the drainage volume. Drainage waters with concentrations well in excess of 6 000 milligrams per litre (6,000 parts per million), and possibly as high as 25 000 milligrams per litre (25,000 parts per million), can still be used to grow plants. Although commerical crop species tolerating such high salinities are not currently available, numerous halophytes are known that will yield significant amounts of biomass with brackish water. Scientists can convert this biomass into fuels, on industrial and pharmaceutical chemicals. Part of the technology exists at present; new possibilities would result from further biological, chemical, and engineering research. It also may have substantial benefit for wildlife habitat.

The Panel does not have sufficient information to make quantitative estimates of the potential water savings from reuse of drainage water. However, based on the estimates of others--that the annual drainage volume may reach 493 million cubic meters (400,000 acre-feet) by the year 2000, and as much as 1200 million cubic meters (1 million acre-feet) ultimately--a goal of 50 percent utilization by agricultural crops would point to an effective increased supply on the order of 300 million cubic meters (250,000 acre-feet) per year. Biomass production would reduce the volume further, but not increase supplies for agriculture per se. In no case should these methods be interpreted as fully eliminating the need for removal of drainage water from the basin.

Implementation of drainage water reuse thus would substantially reduce the cost of the drainage outlet facilities needed. However, reuse is not likely to become popular unless a series of institutional, engineering, and incentive problems are resolved. Problems such as collection and distribution of drain water, pricing incentives for growers who use drain water rather than fresh water for irrigation, and ownership disputes can no doubt be resolved if they are clearly identified.

CHAPTER VI. INSTITUTIONAL CHANGES TO PROMOTE CONSERVATION

Present California water institutions came into existence while new surface water supplies were being developed to meet the state's increasing water demands. Until now, these institutions have tended to promote the development and use of new water supplies, rather than the efficient use of existing supplies. But with rising economic, energy, and environmental costs of developing new supplies, it is now appropriate to consider insitutional changes that will encourage water conservation.

In 1928, Californians adopted a constitutional amendment (now incorporated in Article X, Section 2) that declared it was the policy of the State to put its water resources to beneficial use to the fullest extent possible, and to prevent wasteful or unreasonable uses of water resources. Although this amendment was de-emphasized during the extensive development of California's surface storage and conveyance facilities, between the 1930's and the 1960's, in recent years it has been interpreted by the courts and has begun to affect the organization, activities, planning, and decisions of State agencies. And the specific implications of this conservation policy will continue to evolve through additional court decisions, public debates, legislative actions, and agency decisions.

We noted earlier that efficient on-farm water management is seriously hampered by poor data, uncertain water-use efficiencies, and the absence of an overall framework for planning efficient water use. These limitations also hamper the legal, political, and administrative evolution of water conservation; for without appropriate information and concepts, courts will err, political debates will be wasteful, and water agencies will not be able to fulfill their functions. Thus, we encourage the Department of Water Resources to promote improvements in data gathering and to develop useable concepts of efficiency and framework for water conservation planning.

The efficient conjunctive use of surface, ground, and reclaimed waters necessary for water conservation is not generally possible now because of the absence of regional ground water management agencies and overall regulatory authority. With respect to ground water management, the Panel recognizes conflicting interests between agricultural groups in the various regions of the State. These interests, and the prospects of acquiring additional water from imported surface supplies, have delayed the adoption of effective institutions to promote efficient conjunctive management. In the interest of agricultural water conservation, we highly recommend this situation be corrected by: (1) establishing regional ground water districts, and (2) developing a system of ground water management and overall regulatory authority.

One factor that encourages the adoption of irrigated agriculture is low user prices. Low-interest rates, cost pooling and sharing, public funding of environmental protection provisions, and the use of property taxes and standby rates have all helped to keep water-use charges low and the rate of agricultural expansion high. Yet as the State makes the transition from the development of water sources to increasing their efficient use, water-pricing policy needs to be reconsidered. Prices are the principal devices in our economy for allocating the use of scarce resources. Therefore, the Panel recommends that the State of California:

--Consider endorsing the principle of replacement-cost pricing for both surface and ground water.

--Establish a task force to conduct a thorough study of the legal, environmental and equity implications of alternative possibilities of achieving this objective during the remaining decades of this century.

Higher prices will encourage the adoption of water-efficient practices, the use of water-saving devices, and the planting of water-conserving crops. Because replacement cost pricing implies more uniform pricing, cropping patterns could shift in a manner consistent with efficient water use. Replacement cost pricing, however, will not solve every management problem. A pricing structure for ground water should be devised so as to discourage its use in overdrafted areas and encourage its use, relative to the use of surface water, in areas where ground water levels are too close to the ground surface. The Panel encourages the Department of Water Resources, and other agencies, to identify other needed changes in existing regulations so that agricultural production, water conservation, and environmental objectives can be met.

The transition toward replacement cost pricing raises several important issues, including: how the agricultural community will pay for higher priced water, who will receive the surplus revenues resulting from the difference between replacement and delivery costs, and what will become of the water saved through conservation. To resolve these issues, the Panel recommends the State adopt measures to increase the security of tenure to users and allow the rental and transfer of water rights. This proposal, in effect, means moving toward a situation where the farmer owns a certain amount of water (in conjunction with ownership of land) and has the option of renting a portion of his water to another user elsewhere when a means of conveyance exists. Current users would thus be "purchasing" water from themselves, yet treating it as a valuable resource, since they have the option to rent it to others. A gradual move toward security of tenure and transferability will avoid the problems associated with fee simple ownership.

Lastly, when other incentives are deemed inadequate, it may be appropriate for the State to subsidize temporarily some technical changes associated with water conservation.

Without institutional changes such as those discussed above, the Department of Water Resources' opportunities to effectively plan and undertake water conservation activities will remain severely limited.

CHAPTER VII. RESEARCH NEEDS

California's ongoing agricultural research program, related to the use of water, needs to be strengthened. Listed below are specific needs identified in the course of the Panel's deliberations as important to water conservation.

In the plant area, research is needed on the breeding of cultivars that use saline waters, increase marketable product per unit of water, and produce biomass using highly saline waters. Additional information is needed on crop management to achieve economic yields with limited or saline water supplies through appropriate cultural practices such as changing plant densities, varying time of planting, managing plant water stress, reducing soil compaction, shortening the length of the growing season, and using minimum tillage and mulching.

Improved water use and production function are needed for many crops grown in California. More research is needed on those parts of the growing season when plant water stress will not significantly affect the quantity or quality of marketable crops. The relationship between soil-water evaporation and plant transpiration is also needed to evaluate the potential for water conservation by reducing evaporation from irrigated lands.

Further developmemt of on-farm irrigation scheduling techniques is needed. These techniques should take into account the use of water from higher water tables, allow for scheduling with variable optimal depletions, and make the best possible use of water production functions, and climatic data. To make effective use of scheduling techniques, research is needed on delivery systems that will provide optimal water delivery to the farm headgate. In connection with the development of water-scheduling techniques, there is an urgent need for better, rapid techniques or instrumentation for accurately measuring soil-water content or the need for irrigation.

The actual field efficiencies of the various types of on-farm irrigation systems must be determined. Since surface irrigation is the major technique used, engineering and management criteria for these systems deserve high priority. Demonstrations of highly efficient surface irrigation systems must be conducted to encourage their use and minimize water and energy consumption.

Water measurement is a critical part of water management, and new techniques or instruments are needed that offer low-cost, accurate, and minimum-maintenance operation under field conditions, as well as accurate evaluations of leaching fluxes.

Research needs related to the use of low-quality water include the evaluation of irrigation methods compatible with use of drainage and waste waters. A systems analysis could predict the quantity, quality, and location of drainage waters, and indicate methods for the collection and reuse of drainage and waste waters. Chemical problems associated with drainage include: specific ion toxicity, heavy metals, excessive plant nutrients, organic loading, and pesticides.

In connection with planned water-stress techniques, careful summaries of existing research results and additional research on promising crops are needed. Additional information is also needed on the effects of water stress, as related to various parts of the growing season, on the quantity and quality of marketable crops.

Additional information is needed through research regarding the potential of ground water development in all basins, but with special reference to the Sacramento Basin. The possibility of utilizing ground water and recharging it during periods of high flows should be investigated carefully, since this practice could provide additional water resources without developing surface storage capacity.

Finally, water planners need analyses of alternative price incentives and regulatory systems to promote efficient ground water management and use of waste and saline waters. Economic analyses of the potential for drainage and waste-water use for agricultural production, recreation, wildlife, and biomass production will help California's water planners estimate the broad-based potential for agricultural water conservation.

APPENDIX. INPUT AT PUBLIC HEARINGS

On May 14 and 15, 1979, during public hearings at the community center in Pacific Grove, California, the following speakers addressed the Agricultural Water Conservation Panel:

- Dr. Takashai Asano, State Water Resources Control Board
- Mr. Zene Bohrer, California Energy Commission
- Mr. Doanld Clawson, Irrigation Association
- Mr. David DeBruyn, U. S. Bureau of Reclamation
- Mr. Guy Dickey, U. S. Department of Agriculture
- Dr. Ernest Englebert, University of California
- Mr. Donald R. Ford, CH_2M Hill
- Mr. Scott Franklin, California Water Commission
- Mr. Donald Grimes, University of California
- Dr. Om Gulati, State Water Resources Control Board
- Dr. Robert Hagan, University of California
- Mr. Howard Hawkins, Metropolitan Water District
- Mr. Kenneth Henneman, Harvey O. Banks Consulting Engineers
- Mr. Jack Hodges, State Water Resources Control Board
- Mr. Gerald Horner, U. S. Department of Agriculture
- Mr. William Johnston, Westlands Water District
- Mr. Edward Knipling, U. S. Department of Agriculture
- Ms. Phyllis Price, League of Women Voters of California
- Mr. Stuart Pyle, Kern County Water Agency
- Mr. Frank Robinson, University of California
- Mr. Richard Rominger, California Department of Food and Agriculture
- Dr. Kenneth Tanji, University of California
- Mr. John Welty, California State Grange
- Dr. Zack Wiley, Environmental Defense Fund
- Mr. Robert Wollocott, Public Interest Economics

Besides the above speakers, four people submitted written statements for the Panel's consideration. The authors' names are listed below.

- Mr. David Abelson, Planning Conservation League
- Dr. B. Delworth Gardener, University of California
- Ms. Karin Urquhart, Marin Conservation League
- Mr. Gary Weatherford, John Muir Institute

Before the meeting, the Panel received the following texts:

"Water Supply Needs in California", by Ronald B. Robie, March 7, 1979

"Agricultural Water Conservation Research Needs", by Kenneth M. Turner and Boualem Bousseloub, April 1979

"Agricultural Drainage and Salt Management in the San Joaquin Valley", by San Joaquin Valley Interagency Drainage Program, January 1979

Department of Water Resources Bulletins:

76 Delta Water Facilities, July 1978
113-3 Vegetative Water Use in California, 1974, April 1975
160-74 The California Water Plan:
Outlook in 1974, Summary Report, November 1974
198 Water Conservation in California, May 1976

SUPPLEMENT NO. 11

ADVISORY COMMITTEE
ON
AGRICULTURAL WATER PROBLEMS

WATER CONSERVATION IN AGRICULTURE

SHORT AND LONG TERM STRATEGY

September 1980

ADVISORY COMMITTEE

ON

AGRICULTURAL WATER PROBLEMS

WATER CONSERVATION
IN
AGRICULTURE

SHORT AND LONG TERM STRATEGY

This report was prepared for the use of the Committee's sponsoring agencies and other entities in establishing and implementing a viable short term and long term course of action for water conservation in California agriculture.

September 1980

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ORGANIZATION

Advisory Committee on Agricultural Water Problems

Committee Members	Representation
Victor P. Osterli, Chairman	U. C. Cooperative Extension (Retired)
Charles W. Bates, Vice Chairman	Association of California Water Agencies
William I. DuBois	California Farm Bureau Federation
Robert E. Ferguson	San Joaquin Valley Hay Growers
Ronald B. Harrington	Agricultural Council of California
Don Hildebrand	San Joaquin Valley Agriculture
Ed Kimmelshue	Sacramento Valley Agriculture
Mike Storper	Friends of the Earth
Amy Hewes	Planning and Conservation League
Cruz Venstrom	Sierra Club
Bill Hartman	Association of Resources Conservation Districts
Don A. Twogood	Imperial Irrigation District
Alvin Quist	Council of California Growers
Fran Simpson	California Cattle Feeders Association
Ed Willits	Southern California Agriculture

Associate Committee Members	Representation
W. A. Alexander	Tulare Lake Basin Agricultural Quality Management Group
Mike Cantino	U. S. Water and Power Resources Service 1/
Eldridge Cornell	U. S. Agriculture Stabilization and Conservation Service
John Day	State Department of Fish and Game
Phil Woods	U. S. Environmental Protection Agency
Carl L. Stetson	San Joaquin Valley Agricultural Drainage Office
E. B. Knipling	U. S. Science and Education Administration
Bob Miller	U. S. Soil Conservation Service
Glenn B. Sawyer	State Department of Water Resources 1/
Karol M. Enferadi	State Department of Health Services
F. K. Aljibury	State Water Resources Control Board 1/
Thomas K. Beard	California Water Commission
Daniel M. Dooley	State Department of Food and Agriculture 1/
J. L. Meyer	U. C. Cooperative Extension Service

Jack Hodges, Committee Staff

1/ Committee Sponsoring Agencies

State of California THE RESOURCES AGENCY

Memorandum

PEI 10

To : Carla M. Bard
Ronald B. Robie
Richard Rominger
Mike Catino

Date : OCT 15 19

From : STATE WATER RESOURCES CONTROL BOARD

Subject: COMMITTEE REPORT ON WATER CONSERVATION IN AGRICULTURE

In response to the request of the sponsoring agencies for advice regarding water conservation in agriculture, I am pleased to transmit this report. The report was prepared for the use of the sponsoring agencies and other entities in establishing and implementing a viable short term and long term course of action for water conservation in California's agriculture.

This report, in my opinion, expresses the positive position that California agriculture plays a significant role in the production of food and fiber considering the needs of California and the United States. To maintain this role in the future will place increased demands on California's agriculture, especially irrigated agriculture. This in turn will require an increase in available water supplies. The Committee's report indicates that a water conservation program including both water development and water management elements, will be required to meet this challenge. The report states further that, "Improvement in water management does not supplant water development but complements it. Both elements will require appropriate physical facilities and operational criteria giving consideration to inherent trade-offs." I recommend that favorable consideration be given to the perspective for water conservation in agriculture presented by the Committee and the short term and long term strategy for an effective water conservation program.

I would like to take this opportunity to express my appreciation to the subcommittee composed of the following members for the development of the draft report for Committee consideration:

Ed Kimmelshue, Chairman
Ed Willits
Don Twogood
J. L. Meyer
E. B. Knipling

I would also like to thank Jack Hodges, Committee staff, for his efforts in the production of this report.

If you have any questions or comments on this report, please contact me at telephone number (916) 758-2304 or Jack Hodges at telephone number (916) 322-0207.

Victor P. Osterli

Victor P. Osterli, Chairman
Advisory Committee on Agricultural
Water Problems

Enclosure

WATER CONSERVATION IN AGRICULTURE

The Significance of California Agriculture

California's agriculture produces more economic returns than that of any other state, and is one of the most important sectors in the state's economy accounting for $12 billion (1979) in product sales. California produces over 200 different agricultural commodities and leads the nation in the production of 44 of them. California produces about 25 percent of the United States food and fiber, including 50 percent of all fruits and vegetables. California nearly supplies all the almonds, apricots, dates, figs, nectarines, olives, pomegranates and walnuts for the entire nation. Outside of a laboratory or a greenhouse, irrigated agriculture here is as sophisticated as any in the world and is considered to be one of the marvels of the world.

The success of California's agriculture is due to five principal ingredients: climate, water, soil, farmers and technology. The long-term average annual runoff from rain and snow in California is 70.8 million acre-feet.[1/] The 1980 net water use for agriculture and urban purposes has been estimated to be 33.1 million acre-feet[2/] (this takes into consideration the amount of reuse of irrigation return flows. Irrigation for the production of over 200 different food and fiber crops accounts for about 85 percent of the net water use.

1/ Bulletin 160-74, "The California Water Plan - Outlook in 1974".

2/ "Water Supply Needs in California". A presentation before the Assembly Water, Parks and Wildlife Committee on March 7, 1979 by Ronald B. Robie.

Population pressures are placing a strain on our land resources in terms of space for people and their attendant services, and agricultural commodities which they consume. Projections of population growth rate indicate that California may have a population of approximately 29.3 million by the end of this century.[3/]

The race between food and people continues to occupy the minds of those who are concerned for the world scene. "The statistics are not comforting. By the year 2000, according to some estimates, food consumption will double or triple; water withdrawals also may increase two to three times; and nutrients four to five times."[4/] A 1976 report by the National Research Council[5/] estimates the present 4 billion world's population will grow to 6 billion by 2000 AD. It further states that although the agricultural output of the developed countries has doubled in the last 40 years, it has increased by only about 15 percent in the developing countries. Irrigation is naturally looked upon as a means of extending the percentage of the world's land area which can be used for productive agriculture.

If California is to continue to supply its present proportionate share of consumer goods, agricultural production might then be expected to double by the end of the century. This

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3/ California State Department of Finance projection for the year 2000.

4/ Kendrick, J. B., Jr., 1976. Agronomists and Food - Challenges. Pages 27-36. In M. D. Thorne (ed) Agronomists and Food: Contributions and Challenges. American Society of Agronomy, Madison, Wisconsin.

5/ Committee on Climate and Weather Fluctuations and Agricultural Production, 1976. Climate and Food: Climate Fluctuations and U. S. Agricultural Production. National Academy of Sciences, Washington, D. C.

increase in production will require a number of important elements of which land and water resources are two of the principal components. An inventory of California land resources indicates there is potentially 20 million acres of irrigable land of which less than 50 percent are presently irrigated.

Water for the Production of Food and Fiber

The problem of providing water to new irrigable land in California is complex. Water is becoming increasingly expensive and the political and social problems associated with its development have become increasingly difficult in the last 20 years. For example, the cost of new water to the state from the Corps of Engineers' Cottonwood Creek Project is estimated to be between 150 and 180 dollars per acre-foot.[6/] Agriculture and other water users of newly developed water may be expected to bear a larger share of the costs, thus, we are coming to appreciate that the even wiser and more efficient use of currently developed water supplies may be a cost-effective mechanism for satisfying a portion of the water demand.

Certainly an indication of this at a national level is exemplified by the lead statement in President Carter's Water Policy Message of June 6, 1978, which states that "Managing our vital water resources depends on a balance of supply, demand and wise use. Using water more efficiently is often cheaper and less demanding to the environment than developing additional supplies. While increases in supply will still be necessary, these reforms place emphasis on water conservation and makes clear that this is now a national priority."

6/ "Water Conservation in Agriculture". A presentation to the California Association of Reclamation Entities on June 25, 1980 by Falih K. Aljibury.

Water conservation was made a key element of California water policy by a revision in the Department of Water Resources policy in 1975 In recent years, the California Legislature, water districts, various concerned groups and the general public have placed major emphasis on water conservation.

A Perspective for Water Conservation in Agriculture

The term conservation means different things to different people. Webster's New World Dictionary defines conservation as:

> "(1) the act or practice of conserving; protection from loss, waste, etc.; preservation; (2) the official care and protection of natural resources."

The following are a few examples of water conservation methods:[7/]

1. Storing water in surface impoundments allowing for timely releases. This method needs to be evaluated in the context of other beneficial uses.
2. Storing water underground where it is not subject to evaporation or outflow to the ocean. Pumping groundwater is energy consuming and our reliance on it could cause overdrafts, seawater intrusion, and land subsidence and degradation of water quality
3. Lining delivery and distribution canals and ditches reduces seepage losses, but could eliminate or reduce contributions to groundwater recharge and wildlife habitat in some areas.

7/ David C. Davenport and Robert M. Hagan, 1979. Assessing Potentials for Agricultural Water Conservation, Pages 6-11. Western Water, November/December 1979 issue published by Western Water Foundation.

4. Improving irrigation efficiency by reducing tailwater runoff and deep percolation through improved water application systems and timing of irrigations. This could result in reduced leaching of salts and the quantity of return flows used by downstream users. The salt concentration of return flows could be increased. It has been suggested that in some instances improved irrigation efficiency would increase water losses where the water remains in rivers for outflow to the ocean or other irrecoverable sinks.
5. On farm and basin return flow systems, recycling water a number of times within the farm or basin can result in high farm and basin efficiencies. This can result also in some energy and water quality degradations.
6. Reducing irrecoverable flows to salt sinks by diverting or intercepting them for beneficial purposes before they are lost.
7. Use of brackish water through special management, salt-tolerant crops or for biomass production.
8. Through genetics, develop shorter season crops, or varieties that use less water and tolerate drought with economical production.
9. Reducing irrecoverable evapotranspiration losses to the air by modifying water surfaces, watershed and riparian vegetation by crop selection, and by more carefully managing irrigation. Reducing evapotranspiration would clearly reduce the most important losses of pure water. It has been estimated that total evapotranspiration losses (including losses from

watershed vegetation) amount to 150 of the 206 million acre-feet of California's annual water supply. A potential for conservation clearly exists, however, only a portion of this potential for water savings can be realistically achieved with available technology if favorable crop production and economic returns are to be maintained. This potential needs to be evaluated and approaches for improving irrigation technology and water management practices studied. The practicality of reducing evapotranspiration from all vegetated land and especially from irrigated crops needs additional investigation and research.

Optimum water development and water management are the important elements of water conservation. Improvement in water management does not supplant water development but complements it. Both elements will require appropriate physical facilities and operational criteria giving consideration to inherent trade-offs.

Since 85 percent of California's net water use is for the production of food and fiber, a number of people have translated this into a conclusion that if agriculture were more efficient in its use of water, an immediate solution to the water shortage is realized. However, because water is a common pool resource and some of the applied water used is the reuse of agriculture return flow or irrigation seepage -- one irrigator's "waste" may be another irrigator's supply. Water that runs off irrigated farmland or percolates below the plant roots is not always lost, from the viewpoint of the total water resource, since it may return to usable surface and groundwater supplies. Water is not lost unless it evaporates or transpires to the air or flows to a sink such as a perched saline water table or the ocean from which it cannot be feasibly recovered.

Water conservation can be a beneficial undertaking both for the farmer and the consumer. The minimum amount of water a farmer requires is that needed for the consumptive use of his crop and for the leaching requirements of the soil to ensure an appropriate salt balance. The less water a farmer need apply, in approaching this minimum, the better off he will be. The most obvious water conservation benefit is the savings in water from either surface or from groundwater pumping. In the latter instance, this savings is directly related to the cost of energy. The reduced pumping also helps minimize groundwater overdraft problems.

By improving farm irrigation efficiency, farmers realize additional benefits apart from water savings. Excessive applications of water tend to leach certain nutrients from the soil and diminish its productivity. Where farmland overlies shallow perched water tables, excessive applications of water cause perched water tables to rise, soil surface evaporation to increase, and the remaining salts to concentrate within the root zone, adversely affecting plant viability and the ability of the soil bacteria to fix nitrogen, thus decreasing productivity. The perched water may be lost for beneficial use because of its increased salinity content. In short, farmers benefit from cost reduction, improvement of production, and the ability to grow crops more competitively. This, of course, is of direct benefit to the consumer who will see lower prices in the market place.

The reuse of wastewater in agriculture is becoming an alternative in some areas. Reclaimed water offers flexibility in use; it may recharge groundwater basins, and be applied directly to crops and ornamentals. Despite the progress made in this area, a number of conditions still need to be addressed. Institutional, political and financial barriers to the wastewater reclamation program need to be removed. The impact of trace organics and heavy metals on crops needs further investigation. Innovative low energy or low cost processes must be found.

From a basin perspective, groundwater use and water conservation are closely related. Groundwater overdraft increases the cost of extraction, reduces the quality of water in the aquifer, and poses a threat of aquifer subsidence. Thus more efficient use of surface waters and initial amounts of groundwater pumped leads to a reduction of overdraft problems. In the interface of farm management and basin management, "inefficient" use of water by the farmer does not necessarily decrease basinwide efficiency, and that "more efficient" use on the farm does not necessarily save water to the basin, since some water percolating below the root zone may recharge the aquifer. However, even where excess applied water percolates to recoverable sources, the energy account increases basinwide. Water which is twice pumped has twice the energy cost, which must be evaluated in the context of which is more efficient and economically sound.

The costs of meeting net basin demand for water thus vary inversely with the degree of individual conservation efforts. Nonetheless, the concern with overdraft is foremost a concern with water conservation. Water conserved by the farmer may have been recoverable seepage, which replenishes the groundwater reservoir (though sometimes seepage water may contain more particulates than the applied water). Therefore, basinwide conservation can only be accomplished by the prevention of irrecoverable losses through the reduction of evaporation losses and the reduction of losses to saline or other water bodies unusable for agricultural water supply.

An Effective Water Conservation Program - Short and Long Term Strategy

An effective water conservation program for agriculture must have the support and participation of the local interests with the dedicated cooperation of federal and state interests to identify and implement feasible and cost-effective water conservation alternatives. The program must be site specific and consider the other interrelated aspects such as groundwater management, the trade-offs such as energy, and other costs and resources associated with a successful farming operation that are involved.

There are feasible water conservation projects now under way in California. It is imperative that others be identified and implemented. There is also a need to identify needed research efforts that will facilitate implementation of appropriate water conservation projects in the future.

Considering the above concept for water conservation in agriculture, the Advisory Committee on Agricultural Water Problems suggests the following elements be included in the long-term strategy for water conservation in California.

Short Term

1. It is suggested that further recognition be given by all concerned with agricultural water use that essentially all of the following activities are presently under way to some degree in California by water users (growers and farmers), districts (water purveyors), and other local, state, and federal entities. It is the Committee's position that there is a potential to accomplish more in these areas, however, consideration for appropriate action should be on a site specific basis. The following activities are not listed in any specific order of priority:

   a. Irrigation return flow systems.

   b. Low pressure sprinkler and drip irrigation and other improved water application systems.

   c. Land grading for efficient on-farm management.

   d. Canal lining for seepage and phreatophyte control.

   e. Delivery and distribution system, physical and operational modifications to provide irrigation water on demand or need.

   f. On and off-farm drainage facilities construction and operation.

   g. Update water quality objectives in selected basins.

h. Application of existing information and information forthcoming in the short term from research programs relative to water conservation in agriculture.

i. Irrigation water scheduling activities such as IMS.

j. Education. The key element in the success of a waterconservation effort involving the optimum use of water from all sources will be the development and dissemination of appropriate and applicable information. This element shou d include a wide array of entities ranging from student to grower to the general public. The information must be presented in understandable and usable form commensurate with the audience or user. It will be necessary through this element to demonstrate not only the applicability of water conservation methods but their economic, social and environmental values.

Long Term

1. Long term strategies do not indicate the time involved before initiating action, but reflect those elements of the program that will demand considerable planning and arbitration to bring to fruition. Many of the elements listed as short term, such as education, will continue in the long term. The following activities are not listed in any specific order of priority.

   a. Planning and development of surface and groundwater storage facilities and operational criteria.

   b. Establish water use priorities giving consideration to:

      (1) Satisfying present deficiencies.

      (2) Bringing new land into productivity.

   c. Better understanding of groundwater basins and development of mechanisms for conjunctive management with surface water. Local entities would have major responsibility in this activity.

d. Regulations and institutional constraints.

   (1) Modifications to allow flexibility for groundwater recharge during wet years.

   (2) Procedures for water transfer.

e. Financial incentives with sufficient flexibility to address the various situations and circumstances occurring in California agriculture.

f. Research relative to optimizing water use giving consideration to energy resources.

   (1) Reduction of ET.

   (2) Use of brackish water and reclaimed water.

   (3) Plant breeding for shorter season crops, crops that use less water, crops that are more salt tolerant.

   (4) Improved water application systems.

   (5) Improved irrigation water scheduling.

g. Education (see Short Term).

The Committee would encourage increased cooperation and collaboration between federal, state and local entities regarding the above short and long term efforts.

SUPPLEMENT NO. 12

California's Water Future

Policy and Plumbing Go Hand in Hand

A Call to Action by
Governor
George Deukmejian

THURSDAY, APRIL 5, 1984

Lt. Governor McCarthy, Mr. Speaker, Mr. resident Pro tem, members of the Legislaɪre, fellow constitutional officers and ɪllow citizens:

Water is the lifeblood of California. In a ɪmi-arid region, with incomparable climate ıd rich soils, it is our most precious reɪurce.

Over more than 100 years, the people of ɪe state have built a vast, interrelated ɪstem of dams, reservoirs, canals and ydroelectric plants. Every city and town, ɪery farm, every factory has benefited. In any ways, our prosperity as a state has ıralleled our development of water sources.

Local, state and federal agencies have all ayed roles. For example, the Army Corps Engineers has built flood control projects ıd multiple-purpose reservoirs in every ırt of the state. Dams and canals built by ɪe Bureau of Reclamation provide irrigaɔn water for millions of acres of California rmland. The Bureau's hydroelectric ants are a significant source of power for ɔth urban and agricultural needs.

The state has conducted water surveys ıd investigations continuously since the 380's. From these we know that California ıs enough water in its rivers, streams and ıderground basins to meet all of our needs. we develop and use this resource wisely, e can meet the needs of our people, industry ıd farms and still protect our environment.

California is growing again and conıued economic growth is our goal for the future. To succeed, we will need additional water supplies. Agriculture, one of our foremost industries, uses 85 percent of the water that has been developed. We must ensure that enough water is available so that our farms can continue to feed a hungry world.

The two great urban regions in our state, the San Francisco Bay area and the south coastal area, are highly dependent on water imported through long aqueducts. Both regions will need more water to keep pace with continuing growth. Urban growth in the cities of the Central Valley will also contribute to a statewide population which will reach some 34 million by the year 2010.

In recent years, we have seen a great deal of controversy surrounding our water program. The two proposals voted on by the people, Proposition 9 in June 1982 and Proposition 13 in November 1982, were both firmly rejected at the polls. Looking back, it is my judgment these measures were defeated because the people thought they were excessive, reaching beyond demonstrated needs. By contrast, Californians have always supported water development proposals when they were convinced the projects were clearly needed.

In my State of the State message in January, I outlined seven key points which should underlie our policy for a water program. My message today focuses on specific legislative proposals and other actions which add substance to that seven-point framework. Some of the bills have been developed by the Department of Water Resources after numerous meetings with key legislators and interested groups and citizens. Others have been advanced by legislators to meet needs they believe should be addressed.

Water Conservation

A key policy in meeting our needs is to efficiently use water already developed. Our State Constitution sets forth a standard of "reasonable use" in determining how much water one is entitled to use. Over time, as water has become more costly and more in demand, all sectors of water users have acted to improve the efficiency of water use. This trend must continue.

In September, I signed AB 797 (Klehs), which requires urban water agencies throughout the state to develop water conservation plans. This is a significant step toward ensuring more efficient urban water use.

In recent years agriculture, too, has made great strides in reducing unnecessary water use. Methods such as drip irrigation, laser land leveling and sprinklers are now the norm of much of California agriculture.

One of our major opportunities to save water in the state is in the Imperial Valley. Nearly 400,000 acre-feet of water that presently drains unused into the Salton Sea could be saved by such measures as lining irrigation canals with concrete.

Discussions are now getting under way between the Imperial Irrigation District (IID) and the Metropolitan Water District of Southern California (MWD) on a program in which MWD would finance water-saving improvements in the IID system. This program has statewide significance because any water which MWD can obtain by water salvage directly reduces its need to import water from northern California.

Presently, it does not appear that either state or federal legislation is needed for the IID/MWD cooperative program. However,

I strongly support the proposal and my administration stands ready to assist in any way we can.

I am also supporting inclusion in a water bond proposal this year, twenty million dollars ($20,000,000) to be used for low interest loans for water conservation. These loans will be available to public entities for voluntary cost effective capital outlay conservation projects. This revolving fund will provide funds that are needed in the agricultural, as well as, urban communities.

Water Quality

It is the policy of the state to protect the quality of our water resources. Not only the water we drink, but also the water habitat of fish and wildlife must be protected.

In 1969, California adopted the Porter-Cologne Act to administer our water quality control program. In succeeding years it has been amended and strengthened, and is considered the best law in the nation for water quality control.

In September 1983, I signed AB 1362 (Sher), which authorized a program for protecting ground water resources from contamination by leakage from underground tanks. We have budgeted 52 new positions beginning in 1984-85 to administer this program.

We cannot afford to lose scarce water supplies to the careless use of chemicals. To meet the threats to both our surface and ground waters, we need a strong, coordinated program that makes use of the expertise and manpower of the state agencies with authority to act. This administration has recognized the need to deal with toxic threats and will continue to provide the staff needed to make the Department of Health Services, Water Resources Control Board and Department of Food and Agriculture programs effective.

We will also propose funds for the recently ompleted Los Banos Demonstration Dealting Facility. This will enable us to gain iperational experience so we can evaluate he feasibility of desalting agricultural lrainage water to increase water supplies ind to reduce the problems of drainage disiosal in the San Joaquin Valley.

It should be noted that water quality mprovement also is an important purpose f the Delta Water Transfer Facilities. Both xport water quality and Delta water quality vould be enhanced by elimination of everse flows in the lower San Joaquin River. ipecific facilities will also be built in the outh Delta to provide for better water uality for farmers in that area.

Vater Facilities

The complexities of the Sacramento-San oaquin Delta are such that not only water uality, but many other water issues are ıtertwined in both the natural and manged flows through this estuary's channels. 'lood control, water supply, water transfer, ecreation, navigation, fish and wildlife, oadways and utilities—all have their npacts and are impacted by the various ıanagement objectives with which they ıesh.

Much of the water controversy in recent ears has centered on water facilities, with ıe Peripheral Canal being the focal point. ı my judgment, the overwhelming defeat f Proposition 9 (SB 200) in June 1982 iminated the canal as a viable alternative.

In November 1983 the Department of 'ater Resources published a report outlinıg alternatives to the Peripheral Canal. he four plans selected for further evaluıion all involve improvements to the existıg through-Delta water transfer system. he planning is based on the recognition ıat existing water transfer operations are unsatisfactory for water quality, fish and wildlife and water supply management.

The Department has identified three operational objectives which influenced its choice of alternatives and options set forth for consideration:

1. We are trying to develop the hydraulic capacity to divert more water in the winter months which have the highest surplus flows. This requires enlarging the channel capacities in the south Delta, and is the basic purpose of southern options in the alternatives.
2. We want to eliminate the reverse flow in the lower San Joaquin River caused by the export pumps. To do this we need to develop more channel capacity in the northern Delta linking the Sacramento River to the Mokelumne River enroute to the export pumps near Tracy.
3. We want to develop additional storage capacity south of the Delta, both ground water storage and off-stream surface storage.

Completion of Delta facilities would eliminate damage to the fisheries resources caused by reverse flows, would protect water quality of direct diversions from the Delta, and would enable the state project to conserve approximately 500,000 acre-feet a year of additional water supply.

In recognition of his long and constructive efforts to deal with California's water problems in the Legislature, I have asked Senator Ruben Ayala, chairman of the Senate Agriculture and Water Resources Committee, to author the administration's water facilities bill. I have asked Senator Ken Maddy and Assemblymen Dave Kelley and Jim Costa, chairman of the Assembly Water, Parks and Wildlife Committee, to join Senator Ayala as principle co-authors. I have asked Senator Ayala to amend SB 1369 to cover the following five points:

1. A staged Delta facilities plan to improve the through-Delta water transfer system.
2. A fish and wildlife protection plan, required as part of the program.
3. Additional off-stream storage reservoirs in the San Joaquin Valley and southwestern Delta.
4. Ground water storage programs, pursuant to contracts between the state project and the water service contractors.
5. Interconnection of the state's California Aqueduct with other systems such as the Contra Costa Canal and the proposed Mid-Valley Canal.

I believe it is particularly important to develop more capability to store surplus Sacramento River water south of the Delta. The most promising reservoir site is Los Banos Grandes, south of the existing San Luis Reservoir. More storage at this location would provide a place for flood flows, and in addition would provide the increased flexibility of pumping schedules to protect fisheries in the Delta. When a new off-stream reservoir is operated in conjunction with groundwater storage, it will be possible to increase the state project's firm yield by at least 300,000 acre-feet a year.

We also propose to investigate the possibility of an off-stream storage project on Kellogg Creek in the southwestern Delta to provide greater water quality reliability for Contra Costa, Alameda and Santa Clara Counties.

It should be noted that the Department of Water Resources presently has authority under the Burns-Porter Act to develop water transfer facilities in the Delta: from a legal standpoint, legislation is not necessary for Delta facilities. On the other hand, there has been such controversy over the entire matter, I believe it would be helpful toward reaching an accommodation among the various interests for the Legislature to define the Delta facilities and set forth the policies under which they will be developed.

This is the preferable approach. However, if we are unable to obtain approval for the comprehensive proposals outlined in this message, then it may be necessary to proceed under existing authority with a less comprehensive program in order to meet the urgent, long-term water needs of all Californians.

Delta Levees

It is state policy (Water Code Section 12981) to preserve the Delta in essentially its present configuration. Flooding of Delta islands can have adverse impacts beyond the immediate loss of agricultural lands. These impacts include degraded water quality resulting from salt water surging into the Delta; disruption of highway and railway systems; damage to urban and recreational property; loss of fish and wildlife habitat; seepage onto adjacent lands; and loss of fresh water by increased evaporation.

Since 1980, 13 levee failures have inundated Delta islands. Costs of emergency work and restoration have exceeded $75 million. During this same period, three separate planning reports have addressed the levee problem.

I believe the time has come to get started on a comprehensive levee rehabilitation program. The costs should be shared by local, state and federal agencies. Toward this objective I have asked Senator Dan Boatwright to introduce SB 2196 and Assemblyman Bill Baker to carry it in the Assembly. It will authorize expanding the existing state subventions program from $1.5 to $10 million a year, using Tidelands Oil Revenue from the California Water Fund. This program is based on an appropriate share of funding from local reclamation districts on the individual islands.

The Department of Water Resources is working with the Corps of Engineers to develop a federal flood control project as the long-range answer to the Delta levee problem. This will take into account the effects of the state and federal water projects in transferring water through the Delta channels.

Area-of-Origin Protection

An essential point in moving forward with a water consensus is establishing firm protection for the areas in northern California where water originates. Senator Ray Johnson in 1983 introduced SCA 16 which would require a two-thirds vote of the Legislature to amend existing statutes which protect the north. These laws are the Area of Origin Act, the County of Origin Act, and the Delta Protection Act.

I believe SCA 16 is an important part of our water legislation program. It has passed the Senate and is now in the Assembly. This constitutional amendment would be voted on in the general election in November.

In addition, Assemblyman Norm Waters has introduced AB 178 which would extend area of origin protection obligations to projects developed by agencies other than the state or federal government. These proposals merit serious consideration and the administration will work with Assemblyman Waters and others toward reaching a consensus on AB 178.

San Francisco Bay

In recent years there has been increasing concern about potential effects of the large water projects on San Francisco Bay water quality. On one hand, much progress has been made in cleaning up waste discharges in the bay. On the other hand, there is concern that reduced fresh water inflow to the bay from the Delta may degrade the bay's aquatic resources

To address this matter, Speaker Willie Brown has introduced AB 3631, which would provide for coordination of bay investigations and for future standards to protect the bay's beneficial uses. The administration will work with the Speaker and others and hopefully develop a consensus on AB 3631.

Coordinated Operation of Projects

The need to develop an administrative and legal mechanism to ensure that State Water Project and Federal Central Valley Project operations are fully coordinated with each other has been a long standing issue. In particular, the objective is to ensure that the federal project is operated to meet the same Delta water quality standards which the state project must meet. A significant step was made in late 1982 when the operations management people for both projects completed negotiation of a Coordinated Operation Agreement (COA).

At present, the COA is a draft agreement. To complete these arrangements, we propose that California interests join in asking the Congress to authorize the Bureau of Reclamation to formally execute the agreement. In recent months there have been constructive discussions on this subject between those most concerned with Delta protections and those receiving water exported from the Delta. I applaud the spirit of accommodation displayed in these discussions and pledge my support in 1984 to obtain Congressional authorization for the COA.

Completion of the COA would pave the way for up to 500,000 acre-feet a year of interim water supply that would be available for use by the state project immediately. This is water developed by existing federal facilities which will eventually be needed in the federal service areas but is not yet under contract.

Sacramento Valley Water Planning

The major source of water for both the State Water Project and the Central Valley Project is the Sacramento River and its tributaries. This is also where much of the state's remaining irrigable land will be developed

To coordinate investigations in the Sacramento Valley, I have asked Assemblyman Wally Herger to introduce AB 3758. It directs the Department of Water Resources to investigate local supplies and needs, flood control, water quality, drainage, seepage and erosion control. I propose to fund these investigations at a level of $1.3 million in 1984-85 from the California Water Fund.

Non-Project Depletions

It is well recognized that the state and federal water projects have caused much of the Delta's reduced outflows. But many other diversion projects developed by local agencies in the Central Valley and Bay Area also have reduced Delta outflow. Up to one-third of the outflow reduction and its corresponding effects in the Delta is caused by these projects.

The state and federal project water users should not have to pay for mitigation needed because of other diverters. However, it would be virtually impossible to identify the many other projects and calculate their effects on the Delta. These effects must be considered in the aggregate.

To compensate for the depletion effects of these other water projects, I am proposing legislation which would authorize the Department of Water Resources to allocate part of the costs of Delta facilities, such as Suisun Marsh improvements, to other than the state or federal projects. I have asked Assemblymen Richard Katz and Bill Filante to introduce AB 3542 for this purpose. These costs would be funded from the California Water Fund at a level of $3 million in 1984-85. Naturally, state and federal projects would be expected to meet their mitigation responsibilities.

Local Groundwater Recharge

Probably the most economical opportunities for long-term storage of water supplies to carry us through droughts are the state's ground water basins. I am therefore proposing that the state set up a loan program to finance groundwater recharge facilities built by local water districts. I have asked Assemblymen Rusty Areias and Bill Jones to author AB 3626 for this purpose, and Senator Rose Ann Vuich to carry it in the Senate, authorizing the Department of Water Resources to establish and administer the program. I am proposing that we initiate the program with $7 million a year of Tidelands Oil Revenue from the California Water Fund, with the understanding the program can be enlarged as determined necessary by experience.

California Water Fund

I have outlined above several new programs which would be financed from the California Water Fund. Since the late 1960's, this fund has received $25 million a year of Tidelands Oil Revenue for financing construction of the State Water Project. I believe the time has come to redirect these revenues to other vital water purposes.

I have asked Assemblyman Jim Costa and Senator Jim Nielsen to introduce AB 3907 to appropriate money from the California Water Fund for these new programs. Summarizing, in 1984-85, the proposed funding would be:

$10.0	—Delta Levees
7.0	—Ground Water Loans
3.0	—Allocation to Upstream Diversions
1.6	—Sacramento Valley Planning
2.6	—Los Banos Desalter
0.8	—Miscellaneous Water Investigations
$25.0 million	

Fish and Wildlife Protection

Some of California's most valuable environmental and economic resources are its fish and wildlife resources. It is unfortunately true that fish and wildlife have not always been protected as we developed water projects to meet the needs of our growing population. In recent years this issue has been given increased attention. I believe we should not only protect these resources as new projects are built but use our best efforts to correct problems caused by earlier development.

Senator Barry Keene has introduced SB 1500 to fund restoration of fisheries resources that have been reduced by water projects. I agree with his proposal to use Tidelands Oil Revenue for this. I recommend that the $5 million a year of tidelands revenues which have been devoted to state project costs related to the Davis-Dolwig Act be redirected to fisheries restoration. It is appropriate that the Public Resources Code be amended to ensure the policy intent that these funds be available on a continuing basis.

Flood Control

The last three years have witnessed some of the heaviest storms in California's history. With the storms came significant flood problems. Except for the extensive flood control facilities built in previous years, the state would have suffered far worse flooding.

One of the lessons learned from the flooding of recent years is that the authority of the Department of Water Resources to participate in flood fighting activities is clouded by an archaic statute. On many occasions, employees of the Department are called out to organize sandbagging and similar work.

To clarify the Department's authority in these areas, I have asked Senator John Doolittle and Assemblywoman Doris Allen to introduce SB 2145. This bill will not increase state expenditures for flood fighting but will clarify the authority to do what is now being done.

Bond Financing

During the current legislative session, several proposals have developed for providing state bond financing for water-related activities. These include sewage treatment facilities, waste-water reclamation, water conservation, drinking water improvements and flood control. Considering the urgency of these activities, together with the other important bond issues to be voted on by the California electorate this year, I am proposing that the water bonds be consolidated into a single bond authorization of $400 million to be authored by Senator Jim Nielsen and co-authored by Assemblymen Jack O'Connell and Jim Costa, who are the authors of the three bond proposals. Because of the uncertainty of numerous bond proposals being presented for public consideration in the June primary, I am asking that legislative consideration of this consolidated water bond measure be deferred until after the June election.

In Conclusion

In this brief message, it has been possible to outline only the most critical elements of the state's water program, with particular focus on the State Water Project. There are many other activities underway by local agencies, the Department of Water Resources, and the federal government to provide for our water needs.

During the next 25 years the service areas of the State Water Project will require an additional 1.3 million acre-feet a year of water supply even with water conservation. This amount will be needed to offset the loss of Southern California's Colorado River water to Arizona and to accommodate projected growth. The program we are proposing will meet this need by a combination of water development, water salvage, and water transfers.

I believe it is possible for the people of this state to solve water problems in a spirit of accommodation—to put behind them the divisiveness of recent years. We can do this by proceeding step by step to develop that water which is clearly needed, while we ensure protection for the areas in which our water originates.

There is no single measure for meeting our water needs. By the nature of our diversity as a state, the solutions to our problems involve a great variety of actions. Our objectives should be to wisely use our water in promoting mutual prosperity while we protect the state's rich environmental wealth.

The program I have outlined will help our environment, not hurt it. It will improve the quality of our drinking water and thus help us better protect the health of our residents. This program will keep our farmers in business, allow our cities to function without disruption and enable our economy to grow and create more jobs. In short, our water program is in the economic, environmental and health interests of every Californian.

The place to begin this effort is in the legislative process, working on the programs I have outlined in this message. I look forward to working with the members of the Legislature to deal with these problems in a spirit of bipartisan cooperation.

George Deukmejian

Governor

SUPPLEMENT NO. 13

CANALS TO BE CONCRETE LINED DUE TO HIGH SEEPAGE

HOLTVILLE DIVISION

CANAL	LOCATION	MILES
Ash Main	Heading to Lat. 2	1.00
Ash Lateral 15	Heading to delivery 107	2.00
Ash Lateral 30	Delivery 172 to delivery 173	0.50
Ash Lateral 33	Delivery 152 to delivery 152-A	0.25
	Delivery 165 to delivery 167	0.25
Orient	Delivery 2 to delivery 2-A	0.25
Palm	Heading to delivery 2	0.10
	Delivery 6 to delivery 7	0.25
	1/4 mile E. del. 8 to Holtville Mn. Dr.	0.60
Palmetto	Pampas Dr. #1 to delivery 5	0.25
Pampas	Heading to delivery 4	0.75
	Delivery 10 to delivery 12	0.60
	Delivery 23-A to delivery 24	0.25
Pear Main	Delivery 29 to delivery 30	0.75
	Delivery 33 to delivery 45	0.25
Pear Lateral 1	Delivery 43 to delivery 44	0.50
Peach	Delivery 2 to delivery 6	1.50
	Delivery 30 to delivery 34	1.25
Pepper	Heading to delivery 1	0.20
	Delivery 3-A to delivery 4	0.25
Pine	Heading to delivery 4	0.60
Pomelo	Delivery 34 to delivery 37	0.75
South Alamo	Heading to Heber Road	5.50
	Delivery 117 to delivery 119	0.25
Township	Delivery 4 to delivery 6	1.00
	TOTAL MILES	19.85

CANALS TO BE CONCRETE LINED DUE TO HIGH SEEPAGE

EL CENTRO-CALEXICO DIVISION

CANAL	LOCATION	MILES
Acacia	Delivery 62 to delivery 68	1.00
Alamitos	Lat. 8 Hdg. to delivery 54	2.50
Alder	Heading to Alder Lat. 2	2.00
Dogwood	Delivery 1 to delivery 34	1.00
Rose	Delivery 4 to delivery 6	1.00
Wistaria	Delivery 48 to 1/2 mile north	0.50
	Lateral 4 Hdg. to delivery 110	3.00
Wormwood	Heading to delivery 9	1.00
	Delivery 52 to delivery 65	1.25
Wormwood Lateral 7	Delivery 103 to end	2.00
	TOTAL MILES	15.25

CANALS TO BE CONCRETE LINED DUE TO HIGH SEEPAGE

IMPERIAL DIVISION

CANAL	LOCATION	MILES
Date	Heading to delivery 36	1.50
Date Lateral 4	Heading to end	0.25
Date Lateral 5	Heading to end	0.50
Date Lateral 10	Heading to end	1.50
Dahlia	Delivery 52 to delivery 70	1.10
Dahlia Lateral 8	Heading to delivery 55	1.00
Dandelion	Delivery 2 to end	3.50
Elder	Heading to delivery 4-A	0.70
	Lat. 5 Hdg. to delivery 69	2.00
Eucalyptus	Heading to delivery 8	1.50
	Delivery 74 to delivery 75	0.50
	Delivery 106 to delivery 113	1.50
	Delivery 144 to delivery 148	1.00
	1/2 mile so. del. 151 to del. 151	0.50
Eucalyptus Lateral 14	Heading to delivery 114-A	1.25
Fern Side Main	Heading to end	0.50
Fillaree	Heading to delivery 12	3.50
Newside	Delivery 23 to delivery 42	3.00
	TOTAL MILES	25.30

CANALS TO BE CONCRETE LINED DUE TO HIGH SEEPAGE

BRAWLEY DIVISION

CANAL	LOCATION	MILES
Best	Heading to delivery 46	0.25
	Dogwood Rd. to delivery 48	0.50
	Delivery 110 to delivery 120	1.75
Bryant	Heading to Stanley Heading	1.14
Malva Lateral 1	Heading to delivery 2	0.75
Mansfield	Delivery 19 to existing pipeline	0.65
Mesquite	Delivery 5 to delivery 7	1.00
Myrtle	Heading to delivery 3	0.75
Ohmar	Delivery 2 to delivery 4	0.50
Orange	Heading to delivery 4	1.10
Orita	1/4 mile east del. 1 to del. 2-A	1.00
	Delivery 7 to delivery 21	1.00
Osage	Heading to delivery 7	3.00
Oxalis	Heading to delivery 5	1.70
Rockwood	Delivery 133 to delivery 138	1.50
	Delivery 167 to delivery 172	2.00
	TOTAL MILES	18.59

CANALS TO BE CONCRETE LINED DUE TO HIGH SEEPAGE

WESTMORLAND DIVISION

CANAL	LOCATION	MILES
Main Spruce	Heading to Brandt Road	1.00
	Delivery 31 to delivery 34-A	1.00
Sumac	Delivery 46 to Sumac Lat. 4	0.83
Sumac Lateral 1	Heading to delivery 13	0.75
Thistle Main	Heading to delivery 6	1.25
	Delivery 36 to delivery 38	0.50
Thistle Lateral 5	Delivery 13 to delivery 18	1.00
Thistle Lateral 7	Delivery 6 to delivery 13	1.00
Thorn	Heading to delivery 7	1.20
	Delivery 20 to delivery 25	0.50
Thorn No. 1	Delivery 119 to delivery 120	0.25
Trifolium Lateral 2	Heading to delivery 22	0.50
Trifolium Lateral 3	Delivery 45 to delivery 50	1.50
Trifolium Lateral 7	Delivery 135 to delivery 137	1.00
Trifolium Lateral 12	Heading to Baughman Road	1.00
Trifolium Lateral 13	1/2 mile so. del. 250 to del. 253	1.00
Trifolium Lateral 14	Heading to delivery 265	0.50
Trifolium Lateral 15	Delivery 284 to delivery 287	0.75
Trifolium Extension	Heading to delivery 8	1.35
	Poe Heading to Trif. Ext. Lat. 2	2.50
Tuberose	Delivery 140 to delivery 143	1.00
	TOTAL MILES	20.38

CANALS TO BE CONCRETE LINED DUE TO EXCESSIVE SEEPAGE

CALIPATRIA DIVISION

CANAL	LOCATION	MILES
"B" Lateral	Delivery 9 to delivery 11	0.50
	SPRR to delivery 42	1.10
"C" West	Heading to delivery 38	0.50
"E" Lateral	Delivery 24 to delivery 41	3.00
"F" Lateral	Delivery 24 to delivery 31-A	1.50
"G" Lateral	Delivery 10 to delivery 14	1.00
	Delivery 24 to Highway 111	2.50
"H" Lateral	Delivery 24 to SPRR	0.80
"J" Lateral	Delivery 18 to delivery 32	0.50
"K" Lateral	Delivery 10 to SPRR	3.50
"L" Lateral	Delivery 24 to delivery 31	2.00
Nettle	Delivery 3 to delivery 4	0.50
Nutmeg	Delivery 8 to delivery 9	0.75
Vail Main	Lat. 4 Hdg. to Lat. 6 Hdg.	2.00
Vail Lateral 2-A	Delivery 256 to delivery 257	0.25
Vail Lateral 3	Delivery 307 to delivery 309	0.50
Vail Lateral 3-A	Delivery 355 to delivery 357	0.50
	Delivery 364 to delivery 365	0.25
Vail Lateral 5	Delivery 505 to delivery 507	0.50
	TOTAL MILES	22.15

SUPPLEMENT NO. 14

HOLTVILLE DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
All American	Alamo River	63.42	2.60	66.02	
East Highline	No Spill	16.60		16.60	

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Ash Canal	Rositas Canal	2.62	10.38	13.00	
Ash Lat. 2	No Spill		.75	.75	
Ash Lat. 3	No Spill	.76	.24	1.00	
Ash Lat. 4	No Spill		.57	.57	
Ash Lat. 5	No Spill		.50	.50	
Ash Lat. 6	So. Central Drain #2		2.19	2.19	
Ash Lat. 8	No Spill		.55	.55	
Ash Lat. 9	So. Central Drain	.25	2.01	2.26	
Ash Lat. 11	No Spill		.05	.05	
Ash Lat. 12	No Spill		.66	.66	
Ash Lat. 13	Barbara Worth Drain	.76	.99	1.75	
Ash Lat. 15	Ash Lat. 30	2.30	6.45	8.75	
Ash Lat. 16	No Spill	.65		.65	
Ash Lat. 18	No Spill		.49	.49	
Ash Lat. 20	Ash 20 Drain	.80		.80	
Ash Lat. 25	Ash 25 Drain		1.77	1.77	
Ash Lat. 30	Rositas Canal	3.57	3.93	7.50	
Ash Lat. 32	No Spill		.24	.24	
Ash Lat. 33	Ash Lateral 15	.52	3.73	4.25	
Ash Lat. 34	Ash Lateral 30	.50	2.00	[illegible]	
Ash Lat. 35	No Spill		.25	[illegible]	
Ash Lat. 36	No Spill		.50	.50	
Ash Lat. 37	So. Central Dr. #2-A		.68	.68	
Ash Lat. 38	No Spill		.50	.50	
Ash Lat. 39	No Spill	.50		.50	
Ash Lat. 40	No Spill		.49	.49	
Ash Lat. 41	Ash 30-A Drain		.50	.50	
Ash Lat. 42	No Spill		.50	.50	
Ash Lat. 43	Ash 30 Drain	.50		.50	
Ash Lat. 44	No Spill		.25	.25	
Ash Lat. 45	Barbara Worth Drain	.85	.25	1.10	
Ash Lat. 46	Rositas Canal		1.75	1.75	
EHL Lat. 1	EHL #6 Drain		5.43	5.43	
EHL Sidemain	No Spill	.40	2.99	3.39	
EHL Lat. 1A	No Spill		.49	.49	
EHL Lat. 1B	No Spill		.55	.55	
EHL Lat. 2	No Spill		.50	.50	
EHL Lat. 3	Verde Drain #2-B and Verde Drain #2-C		1.00	1.00	
EHL Lat. 4	Verde Drain #2-B and Verde Drain #2-C		1.82	1.82	
EHL Lat. 5	Verde Drain #2	1.25		1.25	
EHL Lat. 5B	Warren Dr. 2-C #1		1.00	1.00	

HOLTVILLE DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Pear City Ditch	No Spill	.06	1.19	1.25	
Pepper	Pepper Drain	2.79	6.21	9.00	
Pepper Lat. 2	No Spill		.50	.50	
Pepper Lat. 3	No Spill		.50	.50	
Pepper Lat. 5	Township #2 Drain		.50	.50	
Pine	Pine Drain	2.93	5.32	8.25	
Plum	Plum Drain	.73	7.27	8.00	
Pomelo	Pomelo Drain	4.15	4.60	8.75	
South Alamo	Alamo River	6.32	5.34	11.66	4561
South Alamo Lat. 1	No Spill	.25		.25	
South Alamo Lat. 2	No Spill	.11	.55	.66	
South Alamo Lat. 3	No Spill	.25		.25	
South Alamo Lat. 4	No Spill	.31	.28	.59	
South Alamo Lat. 5A	No Spill	.50		.50	
South Alamo Lat. 6	No Spill		.75	.75	
South Alamo Lat. 10	Schenk 10 Drain		.50	.50	
South Alamo Lat. 11	Schenk 11 Drain		.24	.24	
South Alamo Lat. 12	No Spill		2.00	2.00	
South Alamo Lat. 16	No Spill		.34	.34	
South Alamo Lat. 17	No Spill	.12		.12	
South Alamo Lat. 18	No Spill	.25		.25	
Township	Township Drain	3.37	5.63	9.00	3178
Whitcomb	Bonds Corner Drain		2.33	2.33	
Whitcomb Lat. 1	No Spill		.25	.25	
Whitcomb Lat. 2	No Spill		.25	.25	
Yule	No Spill		.28	.28	

	Total No.	Total Miles
Laterals with Canal Spills	12	65.94
Laterals with Drain Spills	55	262.63
Laterals with No Spills	53	45.06
Total	120	373.63

EL CENTRO DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
All American	New River	16.15		16.15	
Briar	Central Main Canal and A.A. Canal		2.54	2.54	
Central Main	Dahlia Spillway	16.20		16.20	
Rositas Main	Central Drain	9.63	1.51	11.14	
Westside Main	No Spill	6.90		6.90	

Lateral Canals					
Acacia	Rose Canal	6.29	4.11	10.40	
Acacia Lat. 1	No Spill	1.00		1.00	
Acacia Lat. 2	Central Drain #3-F	1.00		1.00	
Acacia Lat. 3	Acacia 5 Drain	.75.		.75	
Acacia Lat. 4	Acacia 5-B Drain		2.50	2.50	
Acacia Lat. 4A	Acacia 5-A Drain	.25	.50	.75	
Acacia Lat. 5	No Spill		.25	.25	
Acacia Lat. 5A	Acacia 5-A Drain	.48	1.27	1.75	
Acacia Lat. 6	Acacia Lat. 9	.25	1.00	1.25	
Acacia Lat. 6A	No Spill		.45	.45	
Acacia Lat. 8	No Spill		.30	.30	
Acacia Lat. 9	Central Drain	2.09	.50	2.59	
Acacia Lat. 10	No Spill	1.01	1.49	2.50	
Acacia Lat. 11	Central Drain #2	.50	.50	1.00	
Acacia Lat. 12	No Spill	.50		.50	
Alamitos	Acacia Canal and Central Drain #3	2.47	4.53	7.00	
Alamitos Lat. 2	No Spill	.24	.26	.50	
Alamitos Lat. 3	No Spill		.30	.30	
Alamitos Lat. 4	Central Main Canal	1.20		1.20	
Alamitos Lat. 4A	No Spill	.35		.35	
Alamitos Lat. 5	Central Drain #3-E		1.00	1.00	
Alamitos Lat. 6	Central Drain #3		1.25	1.25	
Alamitos Lat. 8	Central Drain #3-C		2.00	2.00	
Alder	Dogwood Lat. #6	5.32	7.18	12.50	
Alder Lat. 1	No Spill		.50	.50	
Alder Lat. 2	No Spill	1.00	.50	1.50	
Alder Lat. 3	Alder 2 Drain	1.00		1.00	
Alder Lat. 5	No Spill		1.00	1.00	
Alder Lat. 5A	No Spill		.50	.50	
Alder Lat. 6	No Spill		.50	.50	
Alder Lat. 7	Central Drain #6	2.05	1.70	3.75	
Alder Lat. 10	No Spill	.25		.25	
Alder Lat. 11	Central Drain #3		.25	.25	
Alder Lat. 12	No Spill		.49	.49	
Beech Lateral	New River	.50	6.24	6.74	
Beech Lat. 1	No Spill		.34	.34	
Beech Lat. 2	No Spill		.49	.49	
Birch	A.A. 8-A Drain #1		2.00	2.00	

EL CENTRO DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Birch Lat. 1	No Spill	.25		.25	
Birch P-2 Lat.	A.A. Drain #10	1.13		1.13	
Birch P-2 Pipeline	No Spill		.50	.50	
Birch Lat. 3	Birch 3 Drain		1.06	1.06	
Birch Lat. 4	No Spill		.25	.25	
Briar Lat. 8	No Spill		.06	.06	
Daffodil	Heber Drain	.78	2.72	3.50	
Daffodil Lat. 1	No Spill		.50	.50	
Daffodil Lat. 2	No Spill	.16	.34	.50	
Dogwood	Rose Canal	8.11	6.09	14.20	
Dogwood Lat. 1	No Spill	.50		.50	
Dogwood Lat. 2	Dogwood Main	2.47	3.53	6.00	
Dogwood Lat. 3	No Spill		.50	.50	
Dogwood Lat. 4	No Spill		.45	.45	
Dogwood Lat. 5	Date Drain #3		.50	.50	
Dogwood Lat. 6	Mesquite 6 Drain	.95	2.30	3.25	
Dogwood Lat. 7	No Spill		.50	.50	
Dogwood Lat. 9	No Spill	.50		.50	
Dogwood Lat. 10	McCall Drain	.56	.94	1.50	
Dogwood Lat. 10A	No Spill	.50		.50	
Dogwood Lat. 11	No Spill	.50		.50	
Dogwood Lat. 13	Central Drain #5		.51	.51	
Redwood	Rose Outlet	7.36	5.07	12.43	4289
Redwood Lat. 1	No Spill		.79	.79	
Redwood Lat. 2	No Spill		.68	.68	
Redwood Lat. 3	No Spill	.50		.50	
Redwood Lat. 4	No Spill	.23		.23	
Redwood Lat. 5	Rose Drain #8	.78	2.22	3.00	
Redwood Lat. 5A	No Spill		.75	.75	
Redwood Lat. 6	No Spill	.25		.25	
Redwood Lat. 7	No Spill	1.00		1.00	
Redwood Lat. 8	Redwood 8 Drain	1.04	1.96	3.00	
Redwood Lat. 8A	No Spill		.50	.50	
Redwood Lat. 11	No Spill		.18	.18	
Rose	Lilac Drain	13.27	.08	13.35	3062
Rose Lat. 1	No Spill	1.25		1.25	
Rose Lat. 2	McCall 4 Drain	1.00		1.00	
Rose Lat. 3	Rose Drain #3-A	.26	1.99	2.25	
Rose Lat. 4	No Spill		.24	.24	
Rose Lat. 6	No Spill	.50		.50	
Rose Lat. 7	No Spill	.50	.50	1.00	
Rose Lat. 8	No Spill	.75		.75	
Rose Lat. 9	No Spill	.25		.25	
Roselle	Mesquite Drain	1.25		1.25	
Rubber	Rubber Drain and Mesquite Drain	5.23	2.02	7.25	
Rubber Lat. 1	No Spill		.50	.50	
Rubber Lat. 2	No Spill	1.00		1.00	
Rubber Lat. 3	No Spill	.50		.50	

EL CENTRO DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Rubber Lat. 4	No Spill	1.00		1.00	
Rubber Lat. 5	No Spill	.50		.50	
Rubber Lat. 6	McKim Drain	.50		.50	
South Date	Date 2 Drain and Dogwood Lat. 2		4.90	4.90	
Walnut	No Spill		.23	.23	
Wistaria	Greeson Drain	4.44	5.96	10.40	
Wistaria Lat. 1	Greeson Drain	2.70		2.70	
Wistaria Lat. 1A	No Spill		.25	.25	
Wistaria Lat. 1B	No Spill		.24	.24	
Wistaria Lat. 2	Greeson Drain	.30	2.33	2.63	
Wistaria Lat. 3	No Spill		.50	.50	
Wistaria Lat. 4	Wistaria 5 Drain	2.00		2.00	
Wistaria Lat. 5	Wistaria 5 Drain	1.75		1.75	
Wistaria Lat. 6	No Spill	1.50	.50	2.00	
Wistaria Lat. 6A	Greeson Drain	.55		.55	
Wistaria Lat. 7	Wistaria 7 Drain	1.00	1.00	2.00	
Wistaria Lat. 8	Greeson Drain	.45	.85	1.30	
Wistaria P-1 Lat.	No Spill	.90		.90	
Wistaria P-2 Lat.	No Spill		.64	.64	
Woodbine	Mt. Signal Drain	2.09	3.51	5.60	
Woodbine Lat. 2	Wells Drain	2.60		2.60	
Woodbine Lat. 3	Mt. Signal Drain	.70	.50	1.20	
Woodbine Lat. 4	No Spill		.50	.50	
Woodbine Lat. 5	No Spill	.20		.20	
Woodbine Lat. 7	Carr Drain		1.55	1.55	
Woodbine Lat. 7A	No Spill	.50		.50	
Woodbine Lat. 8	No Spill		.50	.50	
Wormwood	Wormwood 7 Drain	1.99	7.02	9.01	
Wormwood Lat. 1	No Spill	.50		.50	
Wormwood Lat. 3	Fig Drain #1 and Westside Main Canal	2.00		2.00	
Wormwood Lat. 3A	No Spill		.50	.50	
Wormwood Lat. 4	No Spill		1.20	1.20	
Wormwood Lat. 5	No Spill		.25	.25	
Wormwood Lat. 7	No Spill	1.29	.50	1.79	
Wormwood Lat. 8	No Spill	.30		.30	
Wormwood Lat. 9	No Spill		.50	.50	

	Total No.	Total Miles
Laterals with Canal Spills	9	55.04
Laterals with Drain Spills	50	177.54
Laterals with No Spills	69	48.00
Total	128	280.58

IMPERIAL DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
Central Main	Central Main #4 Spill	8.00		8.00	
Westside Main	Dixie Spill	18.50		18.50	

Lateral Canals					
Dahlia Canal	Newside 1-A Drain	6.54	6.36	12.90	
Dahlia Lat. 1	Date Drain	.47	1.53	2.00	
Dahlia Lat. 4	No Spill		.24	.24	
Dahlia Lat. 5	Central Drain		.48	.48	
Dahlis Lat. 6	No Spill		.49	.49	
Dahlia Lat. 8	Newside Drain #1	1.51	2.49	4.00	
Dandelion	Newside Canal	3.48	1.02	4.50	
North Date	Rose Canal	2.09	5.41	7.50	
Date Lat. 4	Central Drain #11	.50		.50	
Date Lat. 5	No Spill	.50		.50	
Date Lat. 6	McCall Drain #5		1.50	1.50	
Date Lat. 7	No Spill .	.50		.50	
Date Lat. 8	No Spill		.50	.50	
Date Lat. 9	Dolson Drain #1	1.25	.50	1.75	
Date Lat. 10	No Spill	1.50		1.50	
Date Lat. 11	No Spill	.75		.75	
Date Del. 36 P/L	No Spill		.50	.50	
Ebony	No. Central Drain		3.49	3.49	
Elder	Rice Drain #5	3.29	13.91	17.20	7100
Elder Lat. 1	Wildcat Drain		1.50	1.50	
Elder Lat. 2	No Spill	.80	.75	1.55	
Elder Lat. 3	Elder Drain #3	.25	.50	.75	
Elder Lat. 4	No Spill		.25	.25	
Elder Lat. 5	No Spill	.35	.50	.85	
Elder Lat. 5A	No Spill	.50		.50	
Elder Lat. 6	No Spill	.50		.50	
Elder Lat. 7	New River	.25	2.66	2.91	
Elder Lat. 8	No Spill		.99	.99	
Elder Lat. 10	Seeley Drain		1.00	1.00	
Elder Lat. 11	Sunbeam Lake		.63	.63	
Elder Lat. 12	No Spill	1.00		1.00	
Elder Lat. 13	Elder 13 Drain		2.60	2.60	
Elm	Rice Drain #5	2.76	2.74	5.50	
Elm Lat. 1	No Spill		.50	.50	
Elm Lat. 2	No Spill		.30	.30	
Elm Lat. 3	Rice Drain #3	.75	1.81	2.56	
Elm Lat. 4	No Spill		.47	.47	
Elm Lat. 6	No Spill		.55	.55	
Elm Lat. 7	No Spill		.25	.25	
Eucalyptus	New River	7.18	10.82	18.00	8220
Eucalyptus Lat. 2	Wildcat Drain	.61	1.71	2.32	
Eucalytpus Lat. 2B	Wildcat Drain		.36	.36	
Eucalyptus Lat. 4	Wildcat Drain		2.50	2.50	

IMPERIAL DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Eucalyptus Lat. 5	Eucalyptus Canal	.30	3.80	4.10	
Eucalyptus Lat. 7	No Spill	.25	.50	.75	
Eucalyptus Lat. 10	Rice Drain	.53	2.02	2.55	
Eucalyptus Lat. 11	No Spill	.50	.50	1.00	
Eucalyptus Lat. 14	New River	1.40	.53	1.93	
Eucalyptus Lat. 17	North Central #1 Dr.		1.25	1.25	
Eucalyptus Lat. 18	Rice Drain	.50		.50	
Evergreen	Central Main Canal		7.73	7.73	
Fern	Fern Drain & Salt Creek Slough	.12	8.55	8.67	
Fern Lat. 1	No Spill	.15		.15	
Fern Lat. 2	No Spill		.35	.35	
Fern Lat. 3	No Spill		.51	.51	
Fern Lat. 4	No Spill		.20	.20	
Fern Lat. 7	No Spill		.17	.17	
Fern Lat. 8	No Spill		1.53	1.53	
Fern Lat. 9	No Spill .		.49	.49	
Fern Side Main	No Spill	.50		.50	
Fig	Bullhead Slough		4.45	4.45	
Fig Lat. 2	No Spill		.50	.50	
Fig Lat. 4	Fern Drain #1	.16	.65	.81	
Fillaree	Fillaree Drain	5.51	2.39	7.90	4229
Fillaree Lat. 1	No Spill	.10	1.51	1.61	
Fillaree Lat. 1A	No Spill	.19	.21	.40	
Fillaree Lat. 2	No Spill	.75		.75	
Flax	Fillaree Drain #4	1.27	3.33	4.60	
Flax Lat. 1	No Spill		.24	.24	
Flax Lat. 1A	No Spill	.19	.21	.40	
Flax Lat. 3	No Spill		.50	.50	
Flax Lat. 6	No Spill		.30	.30	
Forgetmenot	Westside Drain #1	.20	3.00	3.20	
Forgetmenot Lat. 1	No Spill	.25		.25	
Forgetmenot Lat. 3	No Spill		.25	.25	
Foxglove	Dixie Drain #1	.40	8.80	9.20	
Foxglove Lat. 1	No Spill		.50	.50	
Foxglove Lat. 2	No Spill	.15	.25	.40	
Foxglove Lat. 3	No Spill	.05		.05	
Foxglove Lat. 5	No Spill		.02	.02	
Foxglove Lat. 7	No Spill		.80	.80	
Foxglove Lat. 11	No Spill		.20	.20	
Lotus	Lotus Drain		4.47	4.47	
Lotus Lat. 1	No Spill		.25	.25	
Newside	No Spill	4.09	3.71	7.80	
Newside Lat. 1	No Spill	.20		.20	
Newside Lat. 2	No Spill	.45		.45	
Newside Lat. 3	Newside Drain #1	3.00		3.00	
Newside Lat. 3A	No Spill		1.00	1.00	
Newside Lat. 4	Newside Drain	1.76	.09	1.85	
Newside Lat. 5	No Spill	.50	.50	.50	

IMPERIAL DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Rice	No Spill		.33	.33	

	Total No.	Total Miles
Laterals with Canal Spills	4	23.83
Laterals with Drain Spills	38	165.33
Laterals with No Spills	53	36.04
Total	95	225.20

BRAWLEY DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
Central Main	New River and Eucalyptus Canal	2.14		2.14	
East Highline	No Spill	10.80		10.80	

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Best	Best Drain	3.20	4.55	7.75	
Best Lat. 1	No Spill	.42		.42	
Bryant	No Spill	1.22	.25	1.47	
Lavender	Rose Outlet	4.07	1.43	5.50	
Lavender Lat. 1	No Spill		.31	.31	
Lavender Lat. 1A	No Spill	.60		.60	
Lilac	Lilac Drain	2.48	.47	2.95	
Magnolia	Magnolia Drain	1.56	6.44	8.00	3468
Malan	New River	.25	3.10	3.35	
Malva Lat. 1	Malva 1 Drain	.76	1.24	2.00	
Malva Lat. 2	Malva 2 Drain	5.47	2.73	8.20	
Malva Lat. 2A	No Spill		.10	.10	
Mansfield	Brawley Sewer	.90	1.60	2.50	
Maple	Maple Drain	4.08	3.62	7.70	2799
Marigold	Marigold Drain	4.99	3.96	8.95	
Mayflower	Mayflower Drain	3.26	5.39	8.65	
Mesquite	Mesquite Drain	4.12	3.78	7.90	2756
Moorhead	Alamo River	.10	6.13	6.23	
Moorhead Lat. 1	No Spill		.54	.54	
Moorhead Lat. 2	Alamo River		.43	.43	
Moorhead Lat. 3	Alamo River	.55		.55	
Moorhead Lat. 4	No Spill	.20		.20	
Moss	Moss Drain	3.57	4.53	8.10	2658
Mulberry	Mulberry Drain	4.77	3.63	8.40	
Mullen	Mullen Drain	6.09	2.01	8.10	2146
Munyon	Munyon Drain	4.53	3.27	7.80	
Myrtle	Myrtle Drain	2.03	5.77	7.80	
Oak	Oak Drain	2.99	5.81	8.80	1996
Oakley	Livesley Drain	.97	2.53	3.50	
Ohmar	Ohmar Drain	5.27	4.13	9.40	3078
Oleander	Oleander Drain	4.26	5.04	9.30	3166
Oleander Side Main	No Spill		.25	.25	
Olive	Olive Drain	2.22	2.53	4.75	1464
Orange	Orange Drain	5.02	4.48	9.50	3527
Orchid	Olive Drain	1.76	7.89	9.65	3259
Orita	Orita Drain	2.71	6.59	9.30	2745
Osage	Osage Drain	6.25	3.05	9.30	2211
Oxalis	Oxalis Drain	5.15	3.95	9.10	3115
Rockwood	Vail Canal	6.83	8.73	15.56	
Rockwood Lat. 1	No Spill		.50	.50	
Rockwood Lat. 2	No Spill	.38		.38	
Rockwood Lat. 3	No Spill		.50	.50	

BRAWLEY DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Rockwood Lat. 4	No Spill		.98	.98	
Rockwood Lat. 5	Alamo River	1.50		1.50	
Rockwood Lat. 5A	Jones Drain		.45	.45	
Rockwood Lat. 6	No Spill		.50	.50	
Rockwood Lat. 7	Meserve Drain		.99	.99	
Rockwood Lat. 8	No Spill	.50		.50	
Standard	Standard Drain	5.11	3.34	8.45	
Stanley	Oakley Canal		2.50	2.50	
Stanley Lat. 1	New River		.25	.25	
Stanley Lat. 1A	No Spill	.25		.25	

	Total No.	Total Miles
Laterals with Canal Spills	3	19.13
Laterals with Drain Spills	36	216.17
Laterals with No Spills	16	18.30
Total	55	253.60

WESTMORLAND DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
Westside Main	Trifolium Storm Dr.	19.20		19.20	

Lateral Canals					
Barth	Trifolium 20-A Drain	.90		.90	
Marsh	No Spill		.49	.49	
Poe	Poe Drain	1.00		1.00	
Sandal	Main Spruce Canal		2.59	2.59	
Sandal Lat. 1	Main Spruce Canal		1.41	1.41	
Sandburg	No Spill		.25	.25	
Smilax	No Spill		1.23	1.23	
Smilax Lat. 1	Spruce Lat. 4		.99	.99	
New Spruce	Spruce Main Canal		3.51	3.51	
Spruce Main	New River	2.49	6.51	9.00	3773
Spruce Lat. 1	Spruce 1 Drain	.50	.75	1.25	
Spruce Lat. 3	Spruce 3 Drain		1.00	1.00	
Spruce Lat. 4	New River		4.01	4.01	
Spruce Lat. 5	Cole Drain		2.00	2.00	
Spruce Lat. 6	New River	1.75		1.75	
Sumac	Westside Main Canal	2.35	6.84	9.19	
Sumac Lat. 1	New River	.55	1.89	2.44	
Sumac Lat. 2	Cook Drain	.25	1.51	1.76	
Sumac Lat. 3	No Spill	.25		.25	
Sumac Lat. 4	No Spill		.49	.49	
Tamarack	Tamarack Drain	1.05	4.35	5.40	
Thistle	Westside Main Canal	3.28	6.72	10.00	
Thistle Lat. 2A	No Spill		.31	.31	
Thistle Lat. 3	No Spill		.35	.35	
Thistle Lat. 4	Westside Main Canal	.68	4.57	5.25	
Thistle Lat. 5	Westside Main Canal	1.73	2.77	4.50	
Thistle Lat. 7	Westside Main Canal	1.48	1.02	2.50	
Thistle Lat. 8	Westside Main Canal	.59	1.91	2.50	
Thorn	Westside Main Canal	1.73	3.27	5.00	
Thorn Lat. 1	Westside Main Canal	.50	4.25	4.75	
Thorn Lat. 1A	No Spill		.15	.15	
Timothy	Timothy 1 Drain		2.58	2.58	
Trifolium Ext.	No Spill	4.68	5.78	10.46	
Trif. Ext. Lat. 1	No Spill	.30		.30	
Trif. Ext. Lat. 2	Trifolium 22 Drain	1.29		1.29	
Trif. Ext. Lat. 2A	No Spill	.28		.28	
Trif. Ext. Lat. 7	San Felipe Wash		2.43	2.43	
Trif. Ext. Lat. 7A	No Spill		2.12	2.12	
Trif. Ext. Lat. 8	San Felipe Wash		2.22	2.22	
Trif. Ext. Lat. 9	Trifolium 23 Drain		.72	.72	
Trif. Lat. 1	No Spill		.49	.49	
Trif. Lat. 2	Timothy 2 Drain	1.14	4.01	5.15	
Trif. Lat. 3	Trifolium 3 Drain	3.14	2.11	5.25	
Trif. Lat. 4	Trifolium 4 Drain		4.72	4.72	

WESTMORLAND DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Trif. Lat. 4A	Trifolium 6 Drain	1.00		1.00	
Trif. Lat. 5 North	Trifolium 6 Drain		2.67	2.67	
Trif. Lat. 5 South	Trifolium 4A Canal	.76	1.89	2.65	
Trif. Lat. 6	New River	.40	5.18	5.58	
Trif. Lat. 7	New River	1.92	3.98	5.90	
Trif. Lat. 8	Trifolium 8 Drain	.63	5.62	6.25	1601
Trif. Lat. 9	Trifolium 9 Drain		6.50	6.50	
Trif. Lat. 10	Trifolium 10 Drain	.49	5.66	6.15	1926
Trif. Lat. 11	Trifolium 11 Drain	.97	5.28	6.25	
Trif. Lat. 12	Trifolium 12 Drain	2.02	3.73	5.75	
Trif. Lat. 13	Salton Sea	4.49	1.63	6.12	2716
Trif. Lat. 13A	No Spill		.47	.47	
Trif. Lat. 13B	No Spill		.51	.51	
Trif. Lat. 14	Trifolium 14 Drain	1.15		1.15	
Trif. Lat. 15	Trifolium 15 Drain	1.25		1.25	
Trif. Lat. 16	Trifolium 1 Drain	.78	1.22	2.00	
Tuberose	Westside Main Canal	2.12	2.13	4.25	
Turnip	Westside Main Canal		3.70	3.70	
Westmorland	Westside Main Canal		3.51	3.51	

	Total No.	Total Miles
Laterals with Canal Spills	16	66.30
Laterals with Drain Spills	33	130.64
Laterals with No Spills	15	18.15
Total	64	215.09

CALIPATRIA DIVISION

Main Canals	Spills Into	Earth	Concrete	Total	Acreage
East Highline	"Z" Drain	17.69		17.69	
Vail	Vail Main Drain	13.26	4.59	17.85	
"Z" Waste	Salton Sea	5.00		5.00	

Lateral Canals					
"B"	"B" Drain	4.70	5.45	10.15	
"C" East	"C" Drain	6.12	2.18	8.30	
"C" West	"D" West Canal	.77	2.33	3.10	
"C" Lat. 1	Alamo River	.30	1.00	1.30	
"D" East	"D" Drain	4.84	2.16	7.00	
"D" West	"D" Drain		2.50	2.50	
"E"	"E" Drain	7.31	3.49	10.80	
"F"	"F" Drain	7.40	3.00	10.40	
"G"	"G" Drain	7.68	2.52	10.20	
"G" Lat. 1	"G" Canal	.30		.30	
"G" Lat. 2	No Spill.		.50	.50	
"H"	"H" Drain	4.68	4.82	9.50	
"I"	"I" Drain	3.39	6.01	9.40	
"J"	"J" Drain	7.99	1.01	9.00	
"K"	"K" Drain	5.55	.63	6.18	
"L"	"L" Drain	5.21	2.99	8.20	
"M"	"M" Drain	3.22	3.98	7.20	
"N"	"N" Drain	4.16	4.04	8.20	
Narcissus	Narcissus Drain	4.47	4.93	9.40	
Nectarine	Vail Supply Canal	1.96	.84	2.80	
Nectarine "A"	Vail Supply Canal		4.50	4.50	
Nettle	Nettle Drain	3.28	6.02	9.30	
Niland Ext.	No Spill	4.11		4.11	
Niland Lat. 1	Niland 1 Drain	2.90		2.90	
Niland Lat. 2	Niland 2 Drain	2.20		2.20	
Niland Lat. 3	Niland 3 Drain	2.85		2.85	
Niland Lat. 4	Niland 4 Drain	2.00		2.00	
Niland Lat. 5	Salton Sea	2.35		2.35	
Niland Lat. 6	No Spill	.40		.40	
Nutmeg	Vail Supply Canal	4.47	5.83	10.30	
"O"	"O" Drain	5.63	1.77	7.40	
O'Brien	New River	.40	1.98	2.38	
"P"	"P" Drain	7.50		7.50	2204
"Q"	"Q" Drain	5.64	1.16	6.80	2017
"R"	"R" Drain	5.74	.16	5.90	1656
"R" Side Main	No Spill	1.60		1.60	
"S"	"S" Drain	5.50		5.50	
"T"	"T" Drain	5.22		5.22	
"U"	"U" Drain	2.95	.05	3.00	
Vail Lat. 1	Alamo River	.71	3.49	4.20	
Vail Lat. 2	Alamo River		5.02	5.02	
Vail Lat. 2A	Alamo River	1.91	4.34	6.25	
Vail Lat. 3	Pumice Drain	2.47	4.03	6.50	1933

CALIPATRIA DIVISION (Con't.)

Lateral Canals	Spills Into	Earth	Concrete	Total	Acreage
Vail Lat. 3A	Vail 3-A Drain	4.48	1.52	6.00	
Vail Lat. 4	Pumice Drain	4.47	1.53	6.00	1840
Vail Lat. 4A	Salton Sea	3.31	.99	4.30	882
Vail Lat. 5	Salton Sea	2.99	2.51	5.50	1162
Vail Lat. 5A	Salton Sea & Vail Cut-Off Drain		2.99	2.99	
Vail Lat. 6	Salton Sea	4.75		4.75	280
Vail Lat. 6A	No Spill		.50	.50	
Vail Lat. 6B	No Spill		.50	.50	
Vail Lat. 6C	No Spill		.52	.52	
Vail Lat. 7	Salton Sea	1.78	1.50	3.28	
"W"	"W" Drain	3.00		3.00	
"X"	"W" Drain #1A	.04	.96	1.00	
"Y"	"W" Drain	4.10		4.10	
"Z"	"Z" Waste		1.75	1.75	

	Total No.	Total Miles
Laterals with Canal Spills	5	21.00
Laterals with Drain Spills	49	298.21
Laterals with No Spills	7	8.13
Total	61	327.34

SUPPLEMENT NO. 15

IID Newsgram

WATER
WATER

IT'S NOT EVERYWHERE!!!

Are we doing enough to conserve it?
What happens if we don't?

VOL. 2 NO. 4 AUGUST. 1981

IID NEWSGRAM

WATER CONSERVATION -- Farmers who waste irrigation water will soon be a vanishing breed if the Water Conservation Advisory Board keeps going at the rate it's been going during the past year. First they recommended triple charges for those who waste irrigation water. Later they recommended the charge be increased for those who persisted in wasting water and also recommended expanding IID staff to enforce water conservation measures and to develop new ways to save water. They recommended charging themselves more for water to beef up the District's program of concrete lining irrigation canals and building additional water reservoirs.

In early July, Don Cox succeeded Larry Gilbert as President of the Board. Within two weeks Cox was before the IID Board of Directors with still another recommendation for water conservation -- the use of 8-inch water chokers to be installed on waste boxes. Those who order too much water will find their fields flooded, if the experiment with chokers proves successful.

WHY CONSERVATION IS NOW ESSENTIAL -- Thanks to the physical, mental and political clout of a previous generation, the Imperial Valley is blessed with an abundant supply of water, a supply that will continue only as long as it is used beneficially, and many think it's not. Some Salton Sea property owners have filed suit claiming the District wastes water, causing damage to their property. The Department of Water Resources has charged the District with failing to implement enough water conservation practices. Newspapers throughout the state have flatly charged Imperial Valley farmers with "wasting" water. All of these charges of waste come at a time when other sections of the state and the region are growing more and more desperate for additional water, and are searching for any excuse to legally tap Imperial Valley's water supply.

The charges of waste must be answered. The image of waste must be reversed. Any habits of waste must be stopped. It's the only way Imperial Valley's abundant water supply will continue.

Nobody knows this better than the farmers serving on the Water Conservation Advisory Board.

PUBLIC HEARING -- A public hearing will be held at 7:00 p.m., Tuesday, September 1, to discuss the environmental impact of constructing a 1600 kw hydroelectric plant on the All American Canal at the East Highline Turnout, about 14 miles east of Calexico.

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IID
Newsgram

IID SPENDING PLANS FOR 1982 . . . THE WORD IS FRUGALITY . . .

VOL. 2 NO. 19 JANUARY, 1982

IID'S 1982 BUDGET

With the economy in a downward slide, the IID Board of Directors ruled out $3 million worth of water and power projects and purchases of heavy equipment proposed for 1982. The only spending area left untouched was water conservation, which the Board has set as the District's number one priority for the foreseeable future.

The Board rejected any suggestions of modest increases in water and power rates until there is a noticeable improvement in the Valley's economy.

Their action means IID vehicles will be driven more miles before they are replaced, heavy equipment will serve more hours and a large number of electric typewriters purchased 23 years ago will have to serve at least one more year.

Total budget approved: $109 million.

WATER CONFERENCE -- Robert Y. D. Chun, Chief of the Planning Branch of the Southern District California Department of Water Resources, (DWR) came to Imperial Valley to spell out in detail how DWR came to the conclusion that the IID is wasting water, in spite of the fact that the IID is one of the most efficient irrigation districts in the country. Chun spoke at a water conference sponsored jointly by the Imperial Water Council and the University of California Co-operative Extension.

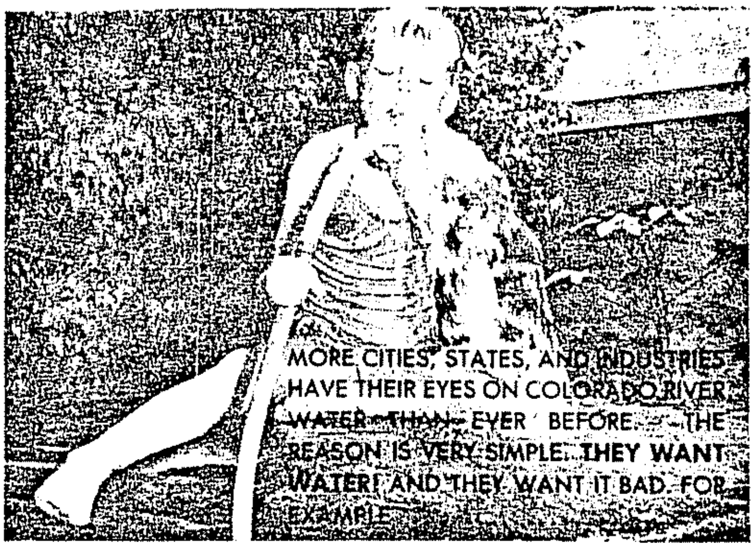
Imperial Valley farmers listened politely and applauded respectfully after Chun spelled out the number of acre feet of water going to the Salton Sea each year and pointed out ways those figures might be reduced.

Most Valley farmers foresee more and more competition for the limited water resources available in southern California and firmly believe that to keep their water they must save it. That, in effect, was the message Chun brought them from DWR.

TRANSMISSION LINE APPROVED -- The California Public Utilities Commission has approved the controversial 500 KV Transmission Line across the southern part of the Valley proposed by the San Diego Gas and Electric Company. Some property owners will be inconvenienced by the line, which is always the case when any transmission line is installed. But the benefits to all Valley residents far outweigh the disadvantages to the few. In the years immediately ahead, the Valley **MUST** import power to meet growing needs for electricity. It can only be done with a transmission line connecting the Phoenix area to the coast, enabling IID to import power or export power in either direction.

CONSERVATION TIP -- Whether it's a home-owner's garage or businessman's warehouse, a coat of white paint on the walls and ceiling will add more light at less cost than adding extra light bulbs. Looks neater too.

WHY CONSERVE WATER?



THIRSTY EYES ON THE COLORADO RIVER

METROPOLITAN L. A. -- In 1985 the Metropolitan Water District (MWD) will have it's Colorado River allotment cut substantially as Arizona begins to pump out an additional 1.2 million acre feet a year. It isn't yet certain where MWD will go to find water to meet the growing needs of the Los Angeles area

NEW INDUSTRIES -- Throughout the 1980's the synthetic fuel industry will be developed in the Rocky Mountain states to extract oil from shale and possibly coal. This massive new industry will require millions of gallons of water, and nobody is yet certain where they'll get it.

The Exxon Company, ever sensitive to the delicate subject of water rights, predicts the possibility of pumping from the Missouri River to the Rocky Mountain states--at a whopping cost of **$1,000 an acre foot.** So far they haven't mentioned, at least not publicly, the possibility of using far less expensive Colorado River water. But everybody knows that possibility exists.

AMPLE WATER BELONGS TO Imperial Valley farmers as long as they use it prudently and beneficially, and not waste it. The question is this; will they use it prudently and beneficially--at all times?

The Salton Sea continues to rise, which has led to a charge that Imperial Valley farmers waste water, a charge the State Department of Water Resources is now investigating. If evidence of waste is found, even if it's just a few farmers, try to imagine the reaction in thirsty L. A., or the interest in the Board rooms of Exxon and other large companies looking for water to launch the multi-billion dollar synthetic fuel industry.

IF A LITTLE IS WASTED, A LOT CAN BE LOST . . . .

IID
NEWSGRAM

THE FLIP SIDE OF WATER CONSERVATION -- IT'S HIGH COST

VOL 4 No. 8 AUGUST, 1983

HIGH COST OF WATER CONSERVATION

Nobody can, or should, argue against water conservation. Those who waste it stand a good chance of losing it. Conservation is a must, an absolute must. But only the naive will overlook its cost -- which is enormous.

The IID's water department recently faced a $5 million deficit, leaving the Board of Directors with no choice but to slash capital improvements, lay off 77 employees, eliminate salary increases and increase water rates as well as institute a new assessment of 50 cents an acre per month on farmland. The near financial crisis was precipitated by heavy rains last winter which cut water sales to almost nothing, and the federal government's PIK program which put thousands of acres of farmland out of production, further cutting water sales. But heavy rains and the PIK program only precipitated the crisis. It began with the high cost of water conservation and inflation.

The IID has had a water conservation program which has received varying degrees of emphasis for three decades. Intense conservation efforts began in 1976, just seven years ago. That's when heavy investments began in expanding the concrete lining program, building reservoirs and experimenting with new and better ways to conserve water and enforce conservation regulations.

During the ten years preceding 1976 the cost of operating the water department increased no more than one to five percent a year. After 1976 the annual increase jumped to an average of 15 percent a year -- mostly due to the increased spending for water conservation. In the long run water conservation saves dollars as well as water, just like insulating a home ultimately saves dollars on air conditioning and heating. But the initial cost is high and it is the initial cost for concrete lining, building reservoirs and buying the multitude of water measuring and recording devices that the IID has faced in recent years, and continues to face.

Water conservation must and will be continued with vigor, but no one should assume it is a worthy cause that is relatively painless. It is a very worthy cause, that is very expensive.

SPEAKING OF WATER -- A valley farmer asked why he orders water by the second foot, yet gets a bill for acre feet. Why, he asked, wasn't he billed for the second feet that he ordered? The answer is, all irrigation districts in California do it that way except where water is metered. It's a water industry practice that began with early irrigation systems and was later incorporated into state and federal regulations for water deliveries and record keeping. The important point for the water user is in converting the number of second feet he ordered into the acre feet he is billed. It's very simple. One second foot equals two acre feet. The water user merely multiplies his water order (second feet) by two and that's how many acre feet he will be billed.

NEEDED: A LITTLE HELP FROM OUR FRIENDS -- During the summer, the hours of peak electricity usage are from noon to 6 p.m. If you can use less electricity during those hours, you will not only help hold the line on your costs, but you also lessen the chance of power outages caused by an overloaded IID system. It helps everybody!!

I I D
NEWSGRAM

THE STATE WATER RESOURCES CONTROL BOARD CAME TO ASK: DOES IID WASTE WATER??

VOL 5 NO 1 JANUARY, 1984

IID NEWSGRAM

DO WE WASTE WATER OR NOT?

For six days the State Water Resources Control Board listened patiently to testimony endorsing or refuting the charge that IID wastes water and thereby causes the Salton Sea to climb steadily higher.

The testimony, more than enough to fill a sizable home library, has been carted off to Sacramento for further study--all to determine one basic question: Does IID waste water?

The question has never been posed to a State Board before, and the answer will not be easy.

Nobody can deny that Imperial Valley farmers could use water more efficiently. On the other hand, IID has been judged one of the most efficient irrigation systems in the world by several federal studies. There was ample evidence presented to prove the system is good. There was equally ample evidence to prove the system could be better.

But do we waste water? The Board is expected to wrestle with the question until May or June before they give their answer.

END OF AN ERA -- An era ended for the Imperial Irrigation District when Executive Officer Robert F. "Bob" Carter resigned at year's end.

Carter, former General Manager, served the District 34 years, participating in construction programs that put IID branch offices throughout the County, concrete lined half the irrigation canals in the system, completed four reservoirs to conserve water, and more than doubled the amount of electricity distributed through IID's power system.

Throughout his career Carter worked twelve hour days, six day weeks; no vacations. "If I had it to do over again I wouldn't work that much," he said. "It wasn't fair to my family. But it was the only way I could get the job done."

century.

Much of this comes to them through the courtesy and sweat of Bob Carter's six-day work weeks.

IID ADOPTS BUDGET LOWER THAN '83 -- The IID Board of Directors unanimously adopted a budget for 1984 that is 12 percent lower than the budget approved for 1983, in spite of slight increases planned in capital expenditures, operation and maintenance costs and a five percent wage increase for employees.

The largest reduction in expenditures will be for purchasing fuel and power. Fuel costs are expected to be somewhat lower per gallon and the District will need considerably less of it -- thanks to an expected continuation of high water

I I D
NEWSGRAM

JUDGEMENTS ARE COMING IN ON THE IID SYSTEM

VOL. 5 NO. 2 FEBRUARY, 1984

IID NEWSGRAM

THE IID SYSTEM -- GOOD SAY THE EXPERTS

IID has been in the midst of some kind of water battle since the District first came into being and today is no exception. Salton Sea property owners have filed suit, charging IID with flooding their property by following "wasteful" irrigation practices. A prominent Imperial Valley farmer, making the same charge, asked the State Department of Water Resources (DWR) to make a full investigation of the IID system -- which they did. DWR later charged the IID with wasting water and asked the State Water Resources Control Board to call a public hearing on the issues -- which they did; giving environmentalists, water attorneys, irrigation experts and pseudo-experts an opportunity to stand in line to testify about IID's so-called "wasteful" irrigation practices. Editorial writers from San Francisco to San Diego to Phoenix all joined the chorus at one time or another screaming "WASTE!" Even a Los Angeles television editorial director joined in.

One good thing to develop from these charges has been the careful studies made of IID irrigation practices by responsible experts in government agencies as well as the courts. The Bureau of Reclamation, for example, made an in depth study of IID's irrigation system. Their conclusion, based on the facts: "IID operates as good or better than any district with a similar distribution system."

Superior Court Judge W. J. Harpham, experienced in water law, listened to expert testimony about IID for eleven long weeks. He not only ruled that the operation of the IID irrigation system is reasonable but added: "The evidence supports the conclusion that IID is equal to or better than other districts."

TRANSMISSION LINE -- It's on its way. The steel towers, first seen creeping across the desert, are now creeping across the Valley. Crews are pulling wire, getting ready to move electricity from Palo Verde, Arizona to San Diego -- with a sizeable amount stopping in Imperial Valley.

The good news is the cost: down from a projected $325 million to the latest estimate of $226 million -- one of the few benefits of the recession. IID's 14 percent share will be reduced proportionately.

Completion date is now guessed to be August, a slippage of a few months because of bureaucratic hangups in getting permits. August will do. Just in time to help with the summer power load.

LET'S TALK -- Don't look for any quick or unusual developments to follow the decision by the IID Board of Directors to talk to other agencies about swapping water for financial help in adding water conservation facilities. To date no talks have been scheduled, no proposals have been made. The Board has merely said, to any and all who have something to say, "Sure, we'll talk to you." Any movement toward a specific agreement of any kind will be made very cautiously.

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WATER CONSERVATION HAS MERIT

VOL. 5 No. 9 OCT. 1984

WATER CONSERVATION BEGINS AT HOME

Water is not the limitless resource we tend to think it is, and homeowners as well as farmers should be aware of the need for conservation. During the month of October, your Imperial Irrigation District in cooperation with the State Department of Water Resources and your local Girl Scouts will be distributing **home water conservation kits.** These **free kits** contain a toilet and shower restricter. Also included is a toilet tank leak detector, and installation pamphlets in both English and Spanish.

If you miss your local Girl Scout or additional kits are needed in your home stop by your local Chamber of Commerce or your Imperial Irrigation District Division office. Remember – conservation begins at home.

ENERGY THEFT
A Crime We All Pay For

People who steal electricity are stealing from you! Thousands of dollars worth of electricity is stolen every year from the Imperial Irrigation District. Eventually you, our customer, pay for this loss through increased power rates.

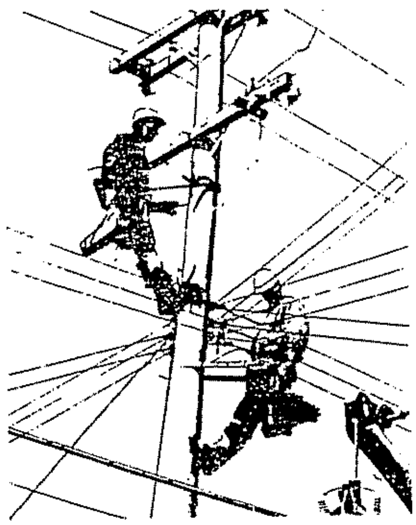
What's more, energy theft poses deadly fire and safety hazards that could kill or injure the energy thieves, as well as their families, neighbors and utility employees.

Please help us stop this serious and dangerous crime.

If you suspect someone of stealing electricity, please phone 339-9364.

IID will investigate suspected energy theft cases to recover lost revenue and will cooperate with law enforcement agencies to prosecute offenders. Energy Theft is punishable by jail term and fine, and full restitution is often ordered as well.

Energy theft is a serious crime we all pay for. With your help, we can stop it.



POST NO BILLS

Posting signs on power poles is illegal and a safety hazard to utility workers. With national elections soon to be held, it is especially important to remind campaign workers not to tack posters on power poles. Those who do post signs, advertisements or pictures on utility poles are in violation of **Section 556.1** of the **California Penal Code**. Nails or tacks lodged in power poles are extremely dangerous to utility linemen, whose climbers tend to slip when they hit any metal objects in the pole.